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Guidance Document for Cleanup of Surface Impoundment Sites

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Prepared for

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This guidance document addresses remedial actions for the cleanup of surface impoundments (defined as a pit, pond, and/or lagoon) containing hazardous wastes. Guidance is provided for the scoping and performance of a limited remedial investigation (limited RI) and limited feasibility study (limited FS). This guidance manual is to be used as an aid to State and Federal staff and private firms for the implementation of a remedial action for the cleanup of hazardous wastes contained in surface impoundments. The manual is informative rather than prescriptive in nature. The basic objectives are to provide a concise description of the necessary steps to implement surface remedial actions for the cleanup of surface impoundments within the provisions of the National Contingency Plan (NCP). It must be emphasized that this guidance is not to be used a an absolute reference. Its use should be supplemented with other EPA guidance documents and technical reports/references as appropriate.

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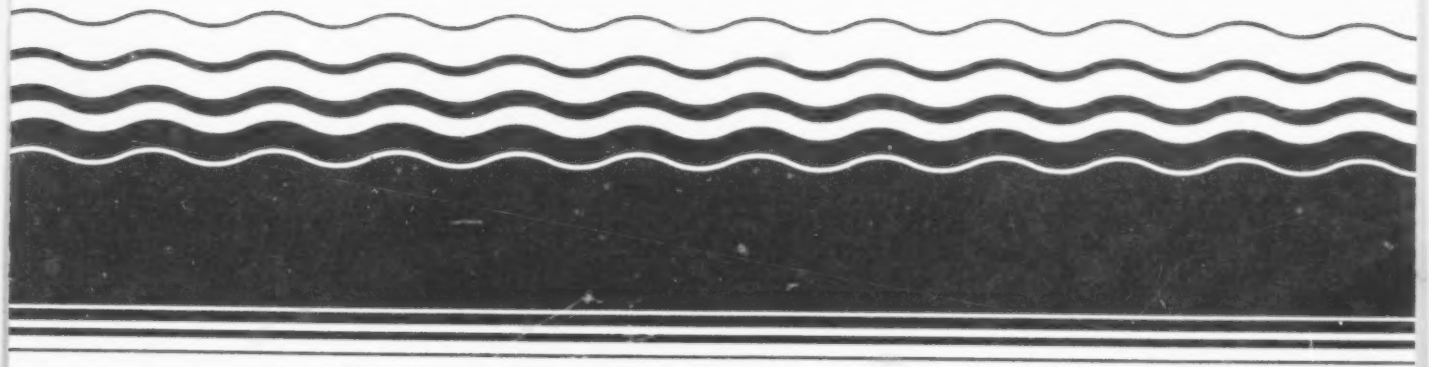

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Foreword

The Comprehensive Environmental Response Compensation and Liability Act of 1980 (P.L. 96-510, commonly referred to as CERCLA or Superfund) established a nationwide program for responding to releases of hazardous materials into the environment as a result of past or present material production, storage, transportation, treatment, or disposal. CERCLA allows EPA to respond rapidly to potential threats to public health or the environment. The Superfund program is implemented through the provisions of the National Contingency Plan (NCP), 40 CFR Part 300.

This guidance document was prepared to assist on-scene federal, state, and local officials and private firms that may plan and implement remedial actions at National Priorities List (NPL) sites having one or more surface impoundments containing hazardous wastes. The primary purpose of this document is to provide guidance on carrying out concurrent remedial action planning activities and accelerating project implementation for the cleanup of surface impoundments containing hazardous wastes. This document is designed to be used in conjunction with the EPA's guidance documents on conducting remedial investigations and feasibility studies (EPA, 1985).

This guidance document will provide the user with a systematic approach to remedial actions for surface impoundments. However, there are many unique and potentially hazardous conditions on NPL sites which require very specialized considerations. This manual does not substitute for the services of competent professionals but is intended to serve as a planning and engineering guidance tool.

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1.0 Introduction

1.1 Purpose

This guidance document addresses remedial actions for the cleanup of surface impoundments (defined as a pit, pond, and/or lagoon) containing hazardous wastes. Guidance is provided for the scoping and performance of a limited remedial investigation (limited RI) and limited feasibility study (limited FS). These limited activities address one "operable unit" at a site that, in the estimation of the lead regulatory agency, can be investigated, evaluated, and implemented in a relatively short time period. An operable unit is one definable problem area or source of contamination at a site that can basically be addressed independently of other site issues and problems. It can typically be thought of as one piece of the total remedial action at a site.

While the term "remedial action" is used, this document may apply to either removal or remedial actions, since both require a similar decision process. However, while the decision process may be similar, the level of detail required in planning will vary widely between remedial and removal activities. Limited RI/FSs are typically the first steps in the remedial response at a National Priorities List (NPL) site and should be consistent with the long term remedy. Remedial actions, as defined by the National Contingency Plan (NCP) in Section 300.68(a), "... are those responses to releases on the NPL that are consistent with a permanent remedy to prevent or mitigate the migration of a release of hazardous substances into the environment." Any remedial action contemplated for implementation at a site must be cost-effective, stabilize the situation, prevent or limit the extent of contamination, and/or provide temporary containment.

Depending on the urgency of response, removal actions may be taken without the preparation of a limited RI/FS, although the issues addressed in an RI/FS will be assessed in an expedited manner.

Typically the RI and the FS can be performed concurrently, with the limited FS finished shortly after the end of the limited RI.

1.2 Intended Use

This guidance manual is intended to be used as an aid to State and Federal staff and private firms for the implementation of a remedial action for the cleanup of hazardous wastes contained in surface impoundments. The manual is informative rather than prescriptive in nature. The basic objectives are to provide a concise description of the necessary steps to implement surface remedial actions for the cleanup of surface impoundments within the provisions of the NCP.

It must be emphasized that this guidance is not to be used as an absolute reference. Its use should be supplemented with other EPA guidance documents and technical reports/references as appropriate. Refer to Section 6.0 for references relevant to the performance of a limited RI/FS for a surface impoundment operable unit. This manual should be used under the direction of an engineer or scientist experienced in hazardous waste remedial projects or equivalent.

Revisions of this manual will be provided, as necessary, to assure compliance with the NCP. Revisions will be made available through EPA for intended users.

1.3 Organization of Guide

This manual is organized into three major sections: (1) initial scoping, (2) limited remedial investigation, and (3) limited feasibility study. These sections represent the major activities to be conducted for the cleanup of surface impoundments. Section 2.0 presents an overview of the process for performing a limited RI/FS for a surface impoundment operable unit. Section 3.0 presents a description of the initial scoping procedure. A detailed review of the steps necessary to conduct a remedial investigation to estimate the characteristics and quantities of wastes stored in impoundments is presented in Section 4.0. An overview of the feasibility study process is presented in Section 5.0; these steps should lead to the evaluation and recommendation of a cost-effective and environmentally sound remedial alternative for wastes in surface impoundments.

The guidance presented in this manual represents a compilation of existing approaches derived from similar remedial actions implemented at many sites where surface impoundments were handled as a single operable unit. However, it will be necessary

to tailor this approach to meet the user's particular needs and the site specific characteristics.

Flow diagrams have been developed to present a logical sequence of activities for the implementation of this type of remedial action. The flow diagrams present the detailed steps for a limited RI and limited FS. The diagrams are located at the beginning of each major section. Each major activity on the flow diagrams is denoted by a rectangle. Diamonds represent decision points and circles indicate starting and ending points for each phase of the entire project. These activities are cross referenced by number to the text in this manual. The user may start anywhere on the flow diagram as long as the predecessor activity has been completed.

The execution of a limited RI/FS for a single operable unit is designed to be very flexible in practice. While many of the component activities are similar to a full RI/FS the user should tailor the approach based upon site specific conditions and other previous and/or ongoing remedial action activities. A limited RI/FS for a surface impoundment site could be initiated during the execution of a full RI/FS or in parallel with other limited RI/FSs (e.g., alternative water supply activities).

1.4 Characteristics of Surface Impoundments

"Surface impoundment" or "impoundment" may be defined as a facility or part of a facility that is a natural topographic depression, man-made excavation, or diked area formed primarily of *earthen* materials designed to hold an accumulation of liquid wastes or wastes containing free liquids. However, impoundments may also be lined with man-made materials. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons. An injection well is not an impoundment.

Exceptions to the above description include specifically designed waste containers such as concrete-lined basins, which should be considered to be tanks. Tanks are stationary devices designed to contain an accumulation of hazardous waste. They are constructed primarily of *nonearthen* materials (e.g., wood, reinforced concrete, steel, or plastic) that provide structural support. A separate guidance document is available for cleanup of surface tank and drum sites (EPA, 1985).

Surface impoundments may range in surface area from a few tenths of an acre to hundreds of acres. Man-made impoundments typically range in depth from 2 feet to as much as 30 feet or more below the land surface. In many instances, impoundments are built above the naturally occurring water table to take advantage of impermeable surface or subsurface soils. In areas with high ground water tables, some impoundments are constructed on the land surface by using dikes or revetments to minimize ground water contact.

Impoundments are typically used for the aeration, oxidation, stabilization, settling, disposal, and storage of wastes. Impoundments may be operated individually or be interconnected so that the flow moves from one impoundment to another in series or parallel. Many impoundments discharge, either continuously or periodically, while others lose their fluids by evaporation or infiltration into the soil. Impoundments may be unlined, permitting seepage of fluids into the soil for the purpose of percolation or infiltration. For certain wastes, impoundments are lined to prevent any seepage of fluid. Typical liner materials include clay, asphalt, soil sealants, and synthetic membranes.

1.5 Operable Unit

The operable unit concept allows phasing of the response actions for a particular site. The primary advantage of performing a separate limited RI/FS for a surface impoundment operable unit is that less time is required to address a contributing contaminant source than for the entire site to be evaluated. This allows action to begin on selected portions of the site, without the delay of waiting for completion of the complete RI/FS for the entire site. However, there are some risks involved when implementing a remedial action for a surface impoundment operable unit if other contaminated areas remain. These risks may include but not be limited to:

- Higher unit cost for a technology that may also be implemented for the other contaminated areas (economies of scale or remobilization)
- Remedy for operable unit not consistent with objectives of entire site

These risks can obviously be minimized by a careful evaluation of site conditions by the lead agency responsible for the site. An operable unit should not be undertaken unless the ground water protection standard has been established or contaminated soil excavation can be undertaken without conflicting with the potential final remedial actions.

2.0 Overview of Process for Conducting a Limited RI/FS for a Surface Impoundment Operable Unit

2.1 General

The evaluation of whether a limited RI/FS can be performed for a surface impoundment operable unit should be based on an evaluation of the impoundment's hydrogeologic characteristics, determined during the initial scoping process. Figure 2-1 shows the overall process for performing a limited RI/FS for a surface impoundment operable unit.

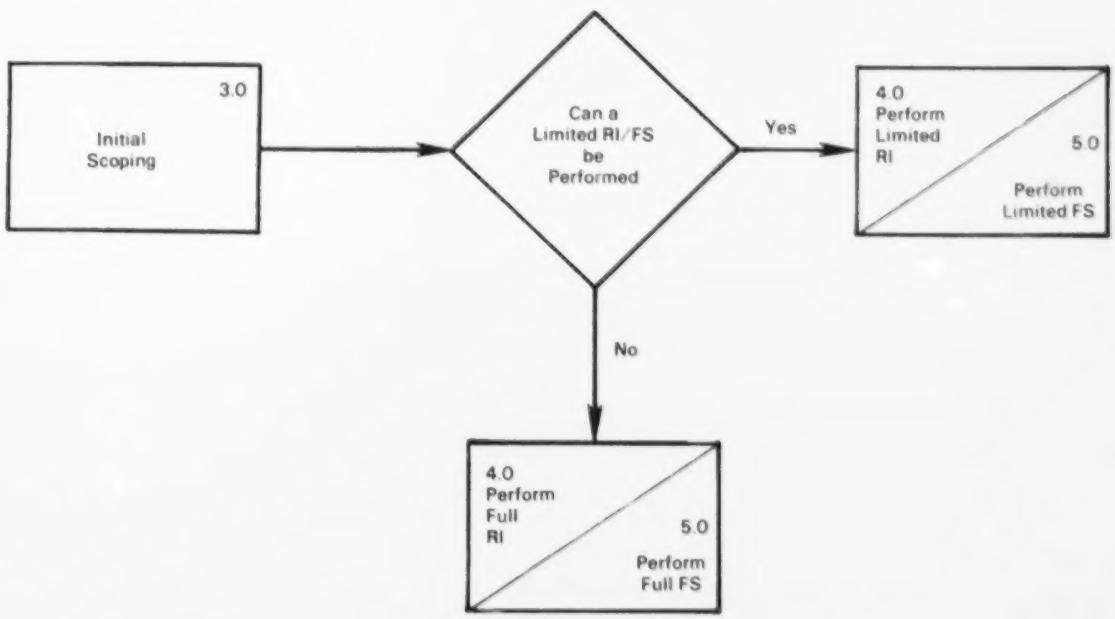
2.2 Major Activities

Initial Scoping. The initial scoping process should be based on existing information regarding the hydrogeologic conditions of the surface impoundment. These conditions influence the amount of information, physical controls, evaluation, and time required to ultimately evaluate and determine an acceptable remedy for the impoundment. This process is presented in Section 3.0.

Limited RI. The limited RI should begin once the decision has been made to perform a limited RI based on the initial scoping process for a surface impoundment operable unit. The primary purpose of a limited RI is to evaluate existing information and conduct field and analytical studies to determine the extent of contamination and risk posed to the public health and environment. The process for the limited RI is presented in Section 4.0.

Limited FS. The limited FS may be conducted concurrently with the limited RI. The limited RI/FS is an interactive process. Data collected in the RI phase are fed into the FS process, where data gaps may be identified, requiring additional RI work, etc. This process leads to a refinement of the remedial alternatives under consideration. The major purpose of a limited FS is to determine the appropriate remedy for the problems posed by the impoundment. The nature of the remedy may be final or temporary depending on several factors. A general overview of the limited FS process is given in Section 5.0.

Figure 2-1. Overview of limited RI/FS process for surface impoundment operations.



3.0 Initial Scoping

The initial scoping process for determining the applicability of an operable unit should be based on existing information on the hydrogeologic conditions of the surface impoundment. The hydrogeologic conditions that would influence the decision for a limited RI/FS may include, but not be limited to:

- Size of surface impoundment
- Waste viscosity
- Depth to ground water
- Leakage of impoundment
- Amount of contaminated soils
- Soil permeability
- Amount of physical controls required for investigation

These conditions will be explained later in this section.

As mentioned previously, there are always risks involved when action is implemented for an operable unit at a site that contains other contaminated areas. Thus, the user is increasing such risk if a limited RI/FS is initiated for a site whose hydrogeologic conditions may favor a full RI/FS.

3.1 Classification System for Determining Applicability of Limited RI/FS

A classification scheme has been developed based on the interconnection of impoundment contents and ground water as a possible tool for evaluating the relative complexity of surface impoundment sites. The important feature of this approach is that it is useful to determine the feasibility of performing limited activities for a surface impoundment operable unit and to define the boundaries of the operable unit.

Not all information required for classifying surface impoundments may be available for scoping a limited RI. In such a case it will be necessary to make assumptions based on existing data. This classification system may be reviewed at the end of each major phase of the limited RI as more data become available.

There are four main scenarios that describe the interconnection of surface impoundments and ground water. These scenarios were developed based primarily on the physical characteristics of a site and describe the complexity of a surface impoundment. As the complexity of the site increases, defining the extent of the operable unit becomes less clear and the scope of the investigation increases. These scenarios are illustrated in Figure 3-1 and are discussed in detail below.

Two of the scenarios have special cases that may require a reassessment of the applicability of a limited RI/FS for a particular impoundment condition. The general guidelines for defining special cases relate to the amount of hazardous wastes and contaminated materials contained in the impoundment, as well as the amount of contaminated soil or ground water that must be handled, treated and/or disposed of in order to evaluate and implement a remedial action for the impoundment.

A decision tree analysis procedure (Section 3.2) has been developed for this classification system.

Under all scenarios, an operable unit should not be undertaken unless the ground water protection standard has been established or contaminated soil excavation can be undertaken without conflicting with the potential final remedial actions.

Scenario A

Scenario A includes those surface impoundments that are situated above the ground water table and are not leaking. The impoundment contents are physically isolated from the ground water and are not being hydraulically transferred from the impoundment to the ground water table. There is limited contaminated soil beneath the impoundment and ground water dewatering is not necessary for decanting liquids from the impoundment.

This scenario includes impoundments with engineered liners or self-sealing impoundments. This scenario, as presented, illustrates a clear division in the extent of contamination and provides a single definable operable unit for a limited RI/FS.

Scenario B

Scenario B includes those surface impoundments

that are situated above the water table and are leaking. The impoundment contents are physically isolated from the ground water but are being hydraulically transferred to the ground water table. Although dewatering is not necessary, there is contaminated soil beneath the impoundment.

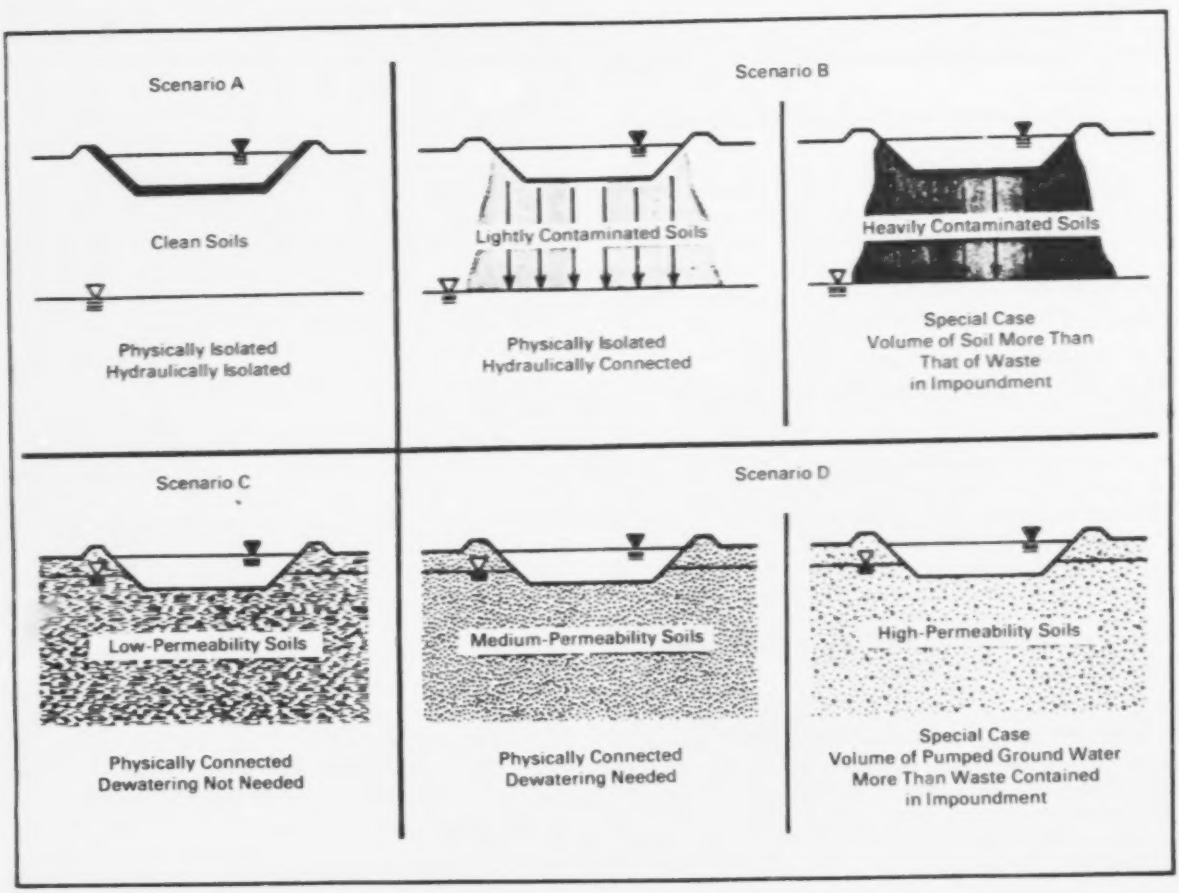
When estimating the volume of contaminated soil that may be handled during the remedial action, several considerations should be made. For example, it may be very difficult to measure the concentrations of contaminants in the soil beneath the impoundment. In this situation, evaluation of contaminant concentrations in the impoundment and in ground water will provide indirect evidence of levels in the soil. Finally, deep impoundments, impoundments with deep soil contamination, and impoundments with high dikes or containment berms pose additional problems relating to side-slope stability if excavation is being considered. Large volumes of soil could generally be handled in these situations, and it may be possible to segregate clean soil excavated for geotechnical (slope stability) reasons from contaminated soil excavated for environmental reasons.

When there is significant soil contamination, good engineering judgment should be used to determine if a limited RI/FS is warranted. A significant short-term threat may favor rapid remedial action. However, an extensive plume originating from the impoundment may favor a full RI/FS for the entire site.

Scenario C

Scenario C includes those surface impoundments that extend below the water table and are situated in relatively impermeable soils. The impoundment contents are physically in contact with the ground water and ground water contamination has (presumably) occurred. However, because the soils have low permeability, substantial ground water in-flows will not occur and dewatering of the soils surrounding the impoundment will not be needed.

Figure 3-1. Classification of impoundments.



Excavations in such situations may not be impeded by water or stability problems because the soils will generally be cohesive.

Scenario D

Scenario D includes those surface impoundments that extend below the water table and are situated in relatively permeable soils. The impoundment contents are in contact with the ground water and ground water contamination has (presumably) occurred. Dewatering of the soils surrounding the impoundment will be necessary in order to decant liquids in the impoundment. If dewatering of soils is not done, ground water in-flows to the impoundment will occur, prolonging the impoundment cleanup activities. Contaminated ground water will also require treatment prior to disposal. When the volume of water pumped is more than the volume of the liquids in the impoundment, the selection of definable operable units for sludges or contaminated soils may be impractical.

Several factors need to be considered when evaluating ground water in-flows to the impoundment and consequent dewatering needs. A principal determinant will be the permeability of the soils surrounding the impoundment. Special cases are more likely to occur when the soils are highly permeable ($K \geq 1 \times 10^{-3}$ cm/sec) and can occur even for moderately permeable soils (1×10^{-6} cm/sec $\geq K \geq 1 \times 10^{-3}$ cm/sec). Large in-flow area and/or hydraulic gradients, both of which would apply to deep impoundments, can compensate for moderate permeabilities in causing special case situations. Finally, if the ground water is not contaminated or is not contaminated to a degree requiring treatment before disposal, it might be possible to dewater even highly permeable soils within the scope of the limited RI/FS program.

3.2 Decision Tree Analysis

Identifying when site specific conditions of a surface impoundment may present a situation beyond the intended scope of a limited RI/FS is a key objective of the decision tree procedure. At various stages in the limited RI it is important to review the key decision points of this evaluation process. As more information is obtained and evaluated during the limited RI process it may become apparent by a re-evaluation, within the structure of this recommended decision tree process, that a particular surface impoundment may be beyond the scope of an expeditious action, even once the limited RI is under way. Even if it is found that it may not be appropriate to address an impoundment within the scope of a limited RI/FS, the evaluation and planning process should continue as part of a full RI/FS.

A "decision-tree" type procedure, presented below, has been developed as a planning tool which can be used in applying evaluation criteria to define the complexity of a particular surface impoundment situation and determine the applicability of a limited RI/FS. This review procedure is designed to focus on the classification scheme developed to generally distinguish different surface impoundment conditions. The specific steps of the decision tree evaluation procedure are summarized in Figure 3-2.

3.2.1 Surface Impoundment Size

The size of an impoundment is a physical characteristic that can affect the complexity of the remedial planning activities.

In general, larger impoundments are associated with larger industrial operations which may have handled a more diverse waste stream. As a result, there is a greater likelihood of multi-level phase separation of waste types and differential settling of sludge/solids across the bottom of the impoundment. In relative terms, as the size of the surface impoundment increases, so does its complexity. The following size restrictions can be used as a guide:

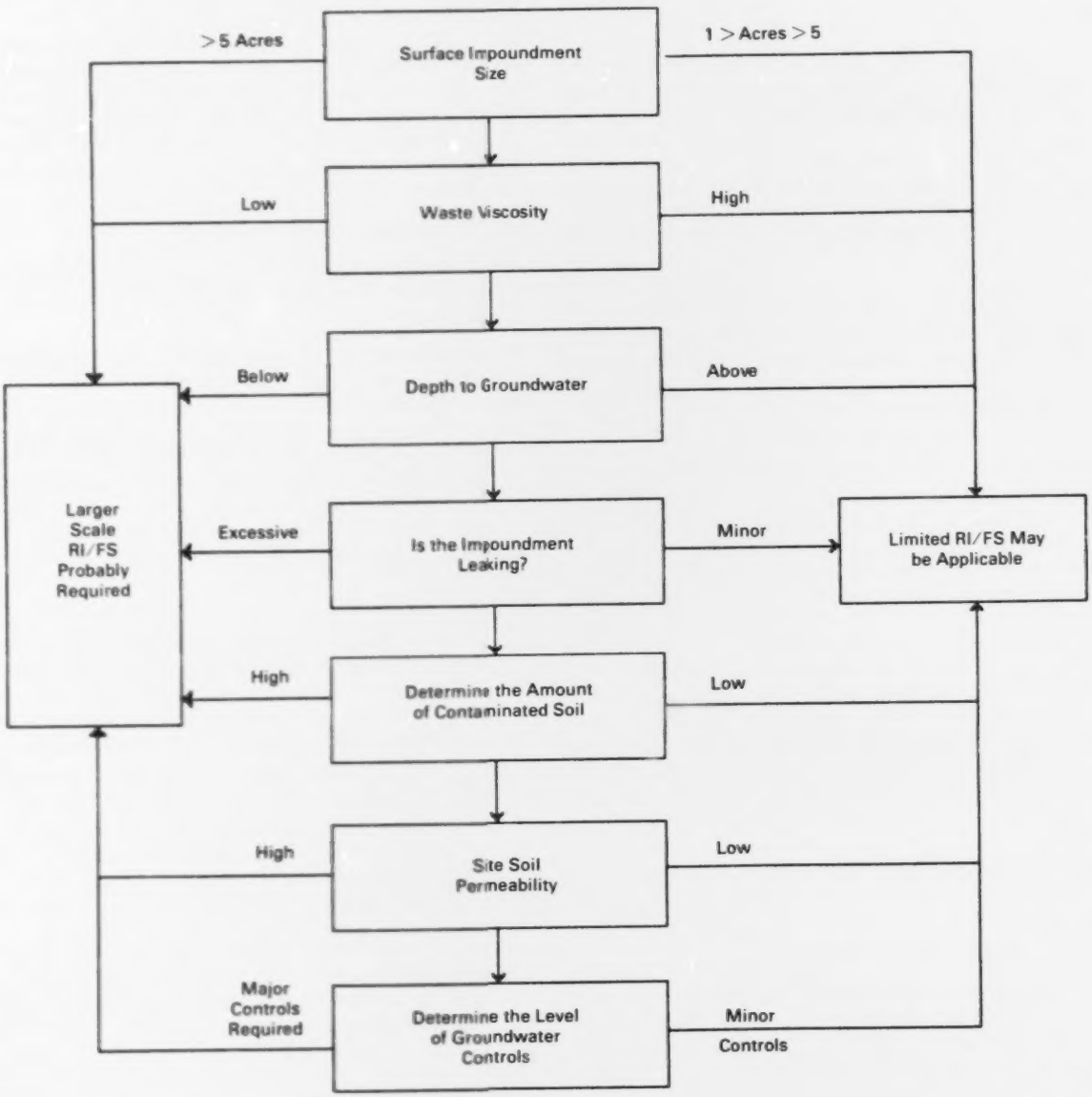
- Less than one acre to five acres—this range limit was selected based primarily on the physical restriction of access. Specifically, the reach of the boom from a type of equipment such as a "cherry picker" for sampling, or the boom of a crane or similar equipment for excavation.
- Greater than five acres—a larger impoundment may contain more varied waste types or phases which require specific treatment trains and the aqueous portion of the impoundment may be of such large volume or dilute nature that its treatment train or portion of it could overlap with the ground water RI/FS, making the combination of the two the logical next step. Remedial actions would be more difficult to implement in a short timeframe compared to smaller impoundments. Larger lagoons are also more difficult to excavate.

3.2.2 Waste Viscosity

The viscosity of the waste material is another physical characteristic that can be used in determining the degree of complexity of a surface impoundment. The viscosity (resistance to flow) also indicates the general extent of how far the actual waste material has moved through soils.

- Highly Viscous Material—the denser or semi-solid material will become more readily bound up in the soil matrix under the impoundment, restricting its movement through the soil. This

Figure 3-2. A process for selecting an operable unit and determining the suitability of a surface impoundment for a limited RI/FS.



does not refer to the material's leachability or movement of contaminants, but indicates how easily the impoundment can be defined, evaluated, and remedied as an operable unit.

- Low Viscous Material—the more liquid material indicates a higher degree of vertical and horizontal flow, or dispersion, into the surrounding soils.

3.2.3 Depth to Ground Water

The depth to ground water influences the amount of ground water contamination from an impoundment.

- Waste Above Ground Water—In areas of low ground water, distinction can be made between the waste material itself, contaminated soil resulting from leaching (or seasonal ground water fluctuations), and contaminated ground water. Remedial alternatives analyzed in the feasibility study may address these threats separately or together.
- Waste Below Ground Water—In this case, at least part of the waste material sets in the ground water, basic contaminant dispersion and the flow gradient through the waste will expand the area and media of investigation resulting in increased effort.

3.2.4 impoundment Leaking

The question of the presence or absence of a liner and the integrity of the liner may indicate the relative complexity of the impoundment study due to possible ground water contamination.

- Non-leaking Impoundments—A single operable unit can be delineated if the impoundment is not leaking. Or, if the amount is so small that very little is migrating from the impoundment, then the limits of work can be defined.
- Leaking Impoundment—Depending on its relationship to the ground water and the extent of contamination, the RI/FS may increase in levels of complexity.

3.2.5 Contaminated Soils

Soils adjacent to the impoundment may be contaminated either due to seepage or the breach of the containment berm. The impoundment volume may be used as a relative guide to measure contaminated soils:

- Less than impoundment volume—This reflects a relatively finite volume of associated contaminted soils which allows for these soils to be handled within the operable unit impoundment study.
- Greater than impoundment volume—The greater volume and relative level of contamination of soils indicates handling the impoundment as a single operable unit may not be the optimal approach for the site. Remedies for the soils may be more practically evaluated with other contaminated areas of the site.

3.2.6 Permeability

Physical data available from simple soil permeability tests or other sources help quantify the decision making process of the previous two steps. Soils underlying the impoundment having a permeability of less than 1×10^{-6} cm/sec may be considered to be relatively tight, impeding migration of contaminants.

- Less than 1×10^{-6}—These soils may resist the migration of contaminants either into the surrounding ground water or of flow by ground water across the site, suggesting that the surface impoundment may be evaluated as an appropriate operable unit.
- Greater than 1×10^{-6}—As the permeability increases the distinction of the waste, soil, and ground water interfaces become less definable, limiting the applicability of an operable unit approach.

3.2.7 Ground Water Controls

The need for physical ground water controls (pumping, and possible treatment processes) during evaluation and remedial action implementation greatly increases with the permeability of the underlying soils, to the point that there may be little distinction between the probable treatment schemes for the waste material and the ground water.

The operable unit approach may be dependent on the volume of ground water that must be pumped which is either greater or less than the relative liquid volume of the impoundment and whether a different waste handling/treatment scheme must be applied.

- Less than—If the ground water volume is less than the liquid volume of the impoundment, then the operable unit approach may be appropriate.
- Greater than—If the ground water volume to be handled greatly increases, then a broader pumping and treatment scheme would be required, limiting the applicability of an operable unit approach.

4.0 Limited Remedial Investigation

After a decision has been reached to evaluate a surface impoundment operable unit, a limited remedial investigation (limited RI) should be performed to provide the information necessry to further define the site, provide the basis to evaluate conditions on the site, and to develop a remedial program to mitigate potential adverse public health and environmental impacts. The four main components of a limited RI are:

1. Develop site description and data base. (Section 4.1)
2. Continue site familiarization and develop project approach. (Section 4.2)
3. Perform initial site characterization. (Section 4.3)
4. Conduct detailed field investigation. (Section 4.4)

A description of these tasks and the associated decision points are presented below. The logic flow diagram for the RI is presented on Figure 4-1.

4.1 Develop Site Description and Data Base

The initial component of the limited RI is to obtain available data describing site conditions (e.g., the nature, amount and character of wastes, the potential for migration from the site or exposure to hazardous materials, and unique site features) and to make an initial evaluation of these data relative to cleanup activities for the site.

4.1.1 Obtain Available Data

Purpose

Data are collected for the following reasons:

- To better define site conditions so that a health and safety plan and sampling plan can be prepared (Section 4.4)
- To provide a basis for initial site evaluation and identification of potential remedial alternatives (Section 4.2.5 and 4.3.1)
- To perform an assessment of current on-site hazards (Section 4.3.3)
- To identify and evaluate existing data base so that future field activities can be planned to fill data gaps (Section 4.3.5)
- To develop a data base for design of an ultimate remedial program (contract documents, plans and specifications)
- To provide data for evaluation of remedial alternatives

Techniques

There are many Federal, State, and local agencies which may have pertinent information useful in conducting a limited RI/FS at a surface impoundment site. Most of the available data may be general in nature but possibly useful in establishing a baseline. In addition to governmental sources, other data sources that may be particularly useful in obtaining more specific information on the conditions of a site include:

- Site history, ownership, operation/disposal practices (past and present, from past owners, operators, and/or generators)
- Sensitive receptors in the vicinity of the site
- Initial planning documents, such as Remedial Action Master Plan if available
- Preliminary assessment/site inspection data
- Aerial photos of the site
- Hazard Ranking System (HRS) documentation

Many other agencies and potential data sources along with types of information that's generally available from these sources are reviewed in *Guidance on Remedial Investigations Under CERCLA* (EPA, 1985).

Limitations

Effort should not be wasted on obtaining data that are not applicable to the scope of the project or are obviously generic or duplicative in nature.

4.1.2 Review and Evaluate Available Data

Purpose

The data should be evaluated and summarized in formats that are easily reviewed by individuals not

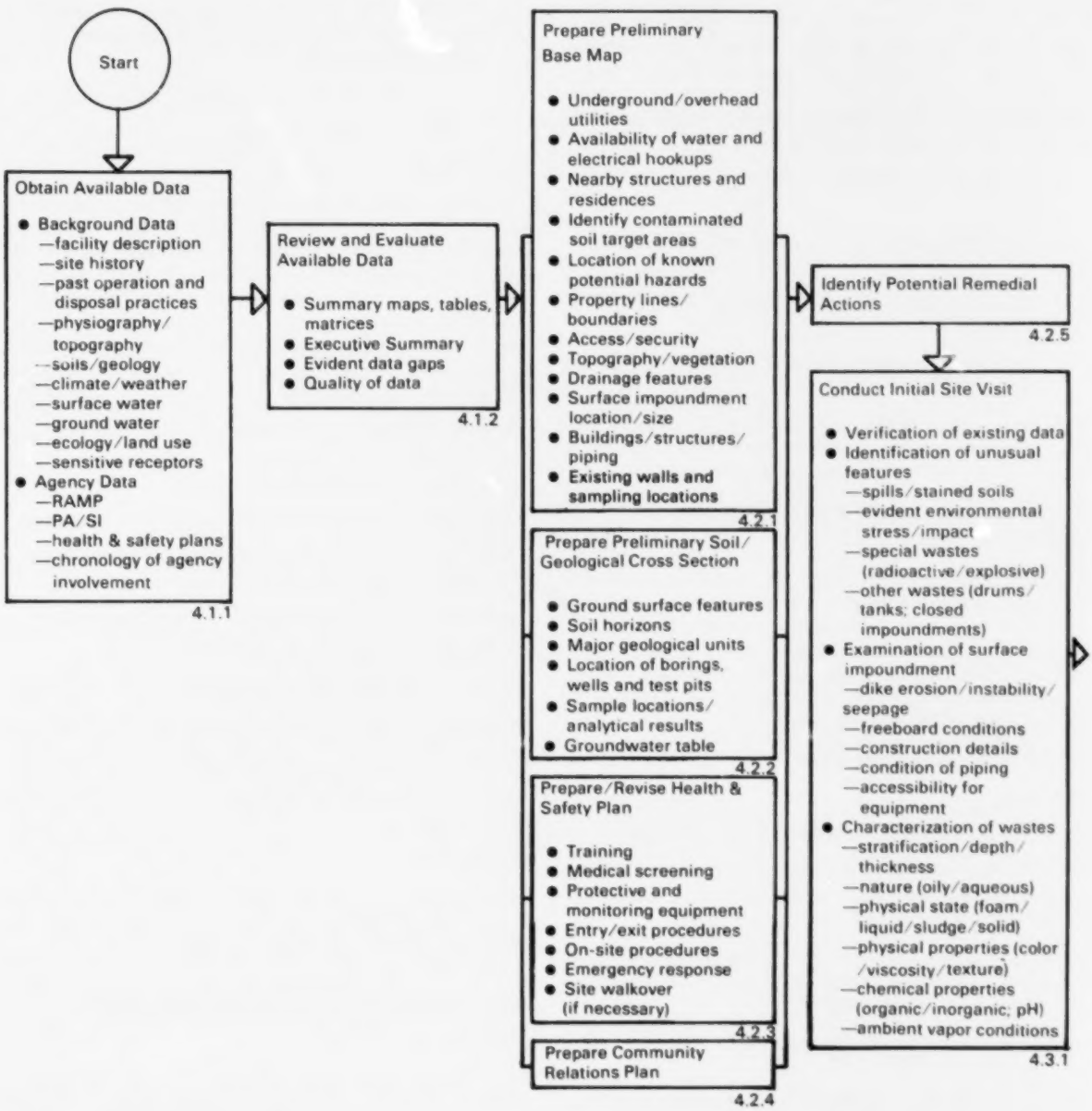
involved in the collection process. By reviewing and evaluating the available data, an understanding of site conditions will be developed and evident data gaps will be identified. During this activity, the quality (i.e., accuracy and precision) of the data and its conformance with the quality assurance/quality control protocols under which it was collected should be assessed.

Techniques

At this early stage it is important to focus on compiling as much information as possible on the characteristics of the surface impoundments. This information includes:

- Conditions of dikes with regard to stability, seepage, and erosion

Figure 4-1. Guidance flow diagram for surface impoundment source control limited remedial investigation.



- Freeboard conditions and site features that could result in changes to liquid levels
- Depth to ground water and seasonal fluctuations in the vicinity of the surface impoundment
- Depth of surface impoundment(s)
- Surface area (individual and total when involving more than one impoundment)
- Evidence of phase separation in the vertical profile of the surface impoundment
- Details of impoundment construction such as dike composition or nature of liners
- Evidence of overflows, leakage, or other spread of contamination
- Nature of soils around/under the surface impoundment (e.g., permeability, type, clay and organics content, etc.)
- Nature and characteristics of material in surface impoundment particularly chemical composition and physical features (e.g., viscosity)

Whenever possible, available data should be summarized in graphic, tabular, or matrix formats. These formats are compact and allow for efficient presentation, comparison, and utilization of large amounts of data. A written summary is also valuable for conveying data trends and general conditions. All summaries, whether graphic, tabular or written, should identify both what is known (conditions at the site) and what is not known (evident data gaps).

An important part of reviewing and evaluating the available data is an assessment of its reliability, that is, the extent to which the data represent site conditions. The dates of maps, drawings, and plans should be checked; sampling locations should be evaluated for representativeness. Analytical data should be checked against internal laboratory QA/QC criteria (blanks, duplicates, spike/recovery); and the methods of sample collection, preservation, handling, and sampler decontamination should be examined for potential irregularities. If more than one laboratory tested samples from the same area on site, the results should be assessed for consistency and variations in methodology should be identified.

Limitations

The data "pool" will be examined to see if the desired information is available. Available data will be evaluated and the need for additional data will be re-evaluated. A balance must be maintained between the need to develop a detailed data base, the need to concentrate on data essential to solving environmental problems at the site, and the need to arrive at the solution as soon as practicable. The quality and accuracy of the data are principal concerns along with the relative timeliness of various data elements.

Figure 4-1. (Continued)

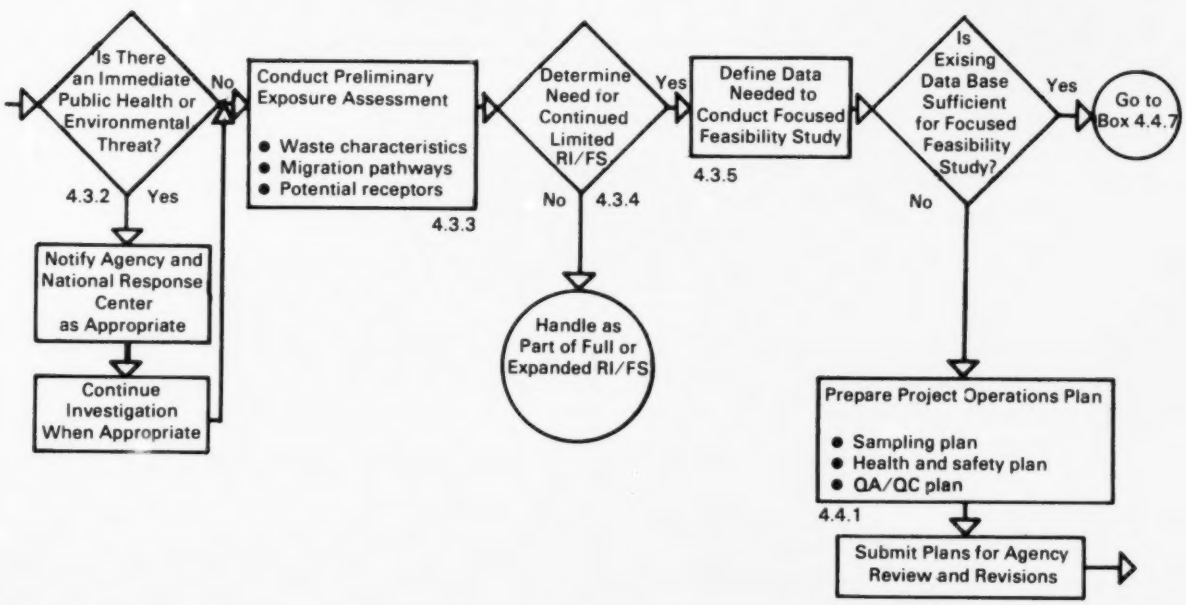
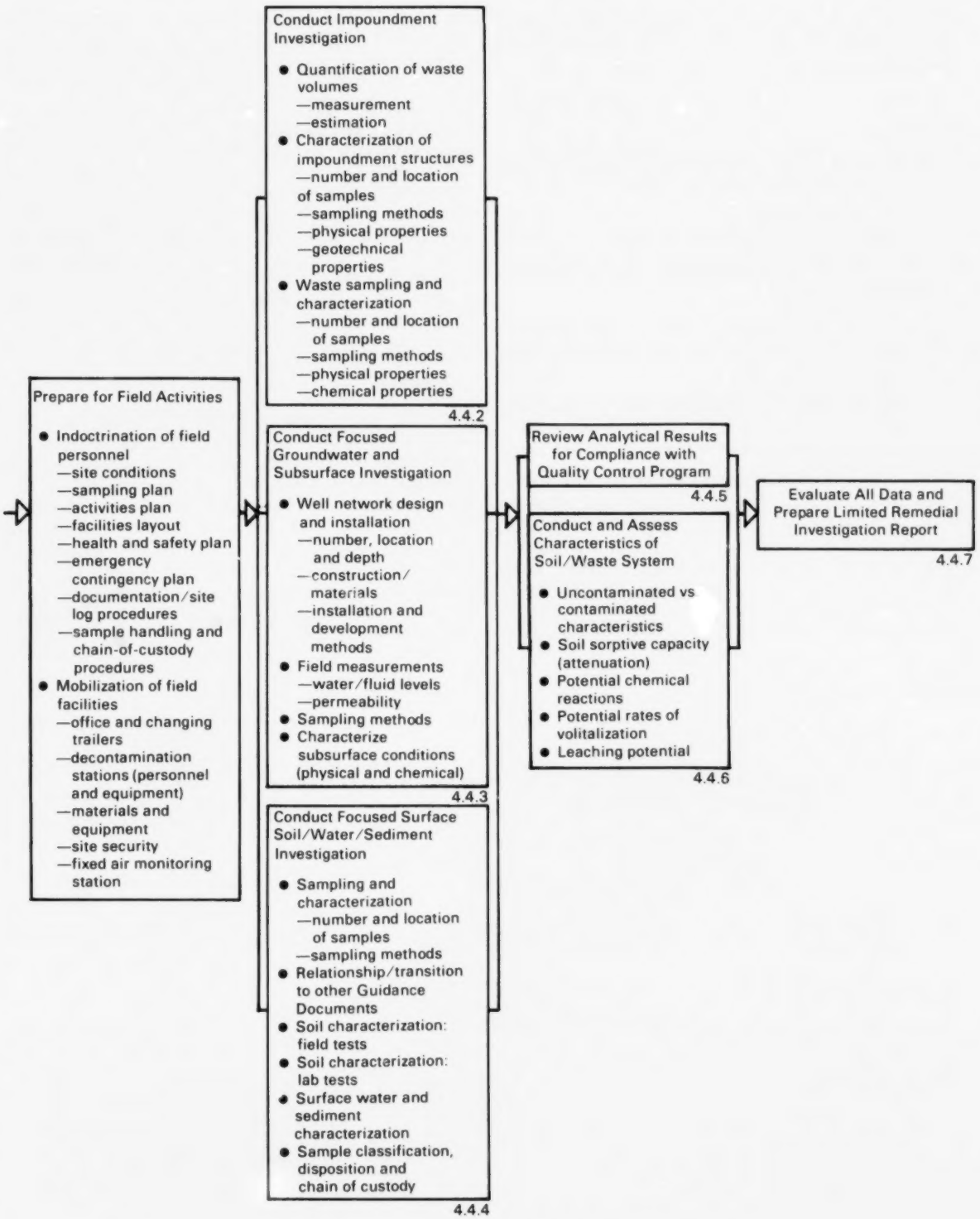


Figure 4-1. (Continued)



4.2 Site Familiarization and Project Approach

The goal of the second major component of the limited RI is to develop the approach (scope) to be followed in subsequent activities. This is accomplished through the preparation of preliminary maps and plans, and the identification of potential remedial technologies. The activities performed during this component are to:

- Prepare a preliminary base map of the site (Section 4.2.1)
- Prepare a preliminary soil/geological cross section (Section 4.2.2)
- Prepare initial health and safety guidelines (Section 4.2.3)
- Prepare a community relations plan (Section 4.2.4)
- Identify potential remedial technologies (Section 4.2.5)

Identification of potential remedial actions that are applicable to site conditions is a key step in the limited RI. By identifying these technologies early in the overall limited RI/FS process, subsequent data collection and analysis can be focused on the development and evaluation of realistic and practicable alternatives. Preparation of a base map, a community relations plan, and an initial health and safety guide will serve to better define site conditions and data needs. The health and safety guide should be prepared in conformance with EPA's *Standard Operating Safety Guides* (EPA, 1984).

4.2.1 Prepare Preliminary Base Map

Purpose

The purpose of this activity is to develop an accurate, detailed, up-to-date map of the site. The preliminary site map is needed to effectively plan the field activities of the initial site visit and is used to record many of the observations made during that visit. In most cases, the preliminary site map will be updated to provide a completed site base map. The base map will provide an accurate representation of the site's impoundment, breaches in dike structures and contaminated soil areas in sufficient detail to provide quantity take-offs, property boundaries, and key physical features to meet all limited RI/FS requirements.

Technique

The preliminary base map can be developed from existing site maps, aerial photos or a site topographic survey. The EPA Environmental Monitoring Systems Laboratory (EMSL) in Las Vegas, NV can provide a wider range of information on a site. EMSL may provide the following:

- Aerial photographs and analysis for a single date
- Aerial photographs and analysis over time either for the site itself or other wider area
- Topographic mapping at 1 foot to 5 foot intervals
- Orthophotographic mapping—a rectified photoimage with a topographic map superimposed.

These services can be obtained through the regional EPA office.

A sample base map is included as Figure 4-2. Features shown on the site map should include:

- Property lines, used to identify boundaries for site access control and site security
- Location, size and pertinent features of all surface impoundments including berms, area of overflow, etc.
- Identified contaminated soil target areas
- Locations of known potential hazards
- Existing piping or interconnections between surface impoundments
- Possible on-site staging/decontamination areas for conductance of geophysical survey and performance of activities during the site/surface impoundment characterization
- Drainage patterns, wetlands, and other water features
- Buildings and structures
- Utilities and other easements
- Wells
- Access/egress points
- Adjacent structures/residences
- Prior sampling locations (on and off site)
- Topography
- Vegetation and other environmental features
- Stained soils, pits, ponds, lagoons and other waste disposal areas
- Site fencing and other security measures

Limitations

Old figures, photos and maps may be useful sources of historic information but should not be relied on for current site conditions. A fly-over of the site to obtain aerial photos may be necessary.

Figure 4-2. Existing conditions site base map example.

4.2.2 Prepare Preliminary Soil/Geologic Cross Section

Purpose

In addition to the site base map, if possible, a preliminary soil/geologic cross section should be developed to provide a three-dimensional overview of soils/geology and the extent of soil contamination at the site. The purpose of this effort is to identify any characteristics, changes or correlation between the type and movement of contamination and soil types and structure. This information will be used to:

- Estimate volume of site soil contamination
- Identify limits/depth of subsurface sampling program
- Select appropriate soil sampling/drilling methods
- Evaluate and design remedial responses

Technique

The preliminary soil/geologic cross section can be developed from existing site maps, soil and geologic publications, any existing soil borings and monitoring well installation reports and analytical results of soil sampling and ground water sampling, if available. A useful type of cross section view is shown in Figure 4-3. Features shown on a cross section of this type should include:

- Ground surface features (e.g., buildings, aboveground tanks, roads)
- Soil horizons
- Major geologic units
- Location of existing borings, wells, test pits and impoundments
- Sample locations and readings from field analyzers
- Ground water table

Limitations

If no soil borings, soil test pits or monitoring wells have been installed at the site, it may not be possible to construct a detailed preliminary cross section. However, geologic and soil publications should be available to give an estimate of the thickness of unconsolidated materials and the depth to the ground water table.

4.2.3 Prepare Initial Health and Safety Guidance

Purpose

An adequate protocol to protect personnel during the initial site visits, (Section 4.3.1) and later during surface impoundment cleanup, is one of the most important aspects of the remedial investigation phase. This initial health and safety guide should be prepared, (or revised, if available) and administered by a trained professional.

Techniques

If an existing health and safety plan has been developed for prior site work, this plan may be adequate for the initial site visit. This document should be reviewed by a qualified professional using the existing site data base (see Appendix A of *Guidance Document for Cleanup of Surface Tank and Drum Sites* [EPA 1985] for an example of a site personnel protection and safety evaluation form). If no plan exists, guidance must be developed based on the existing data. In either case, this guidance must include:

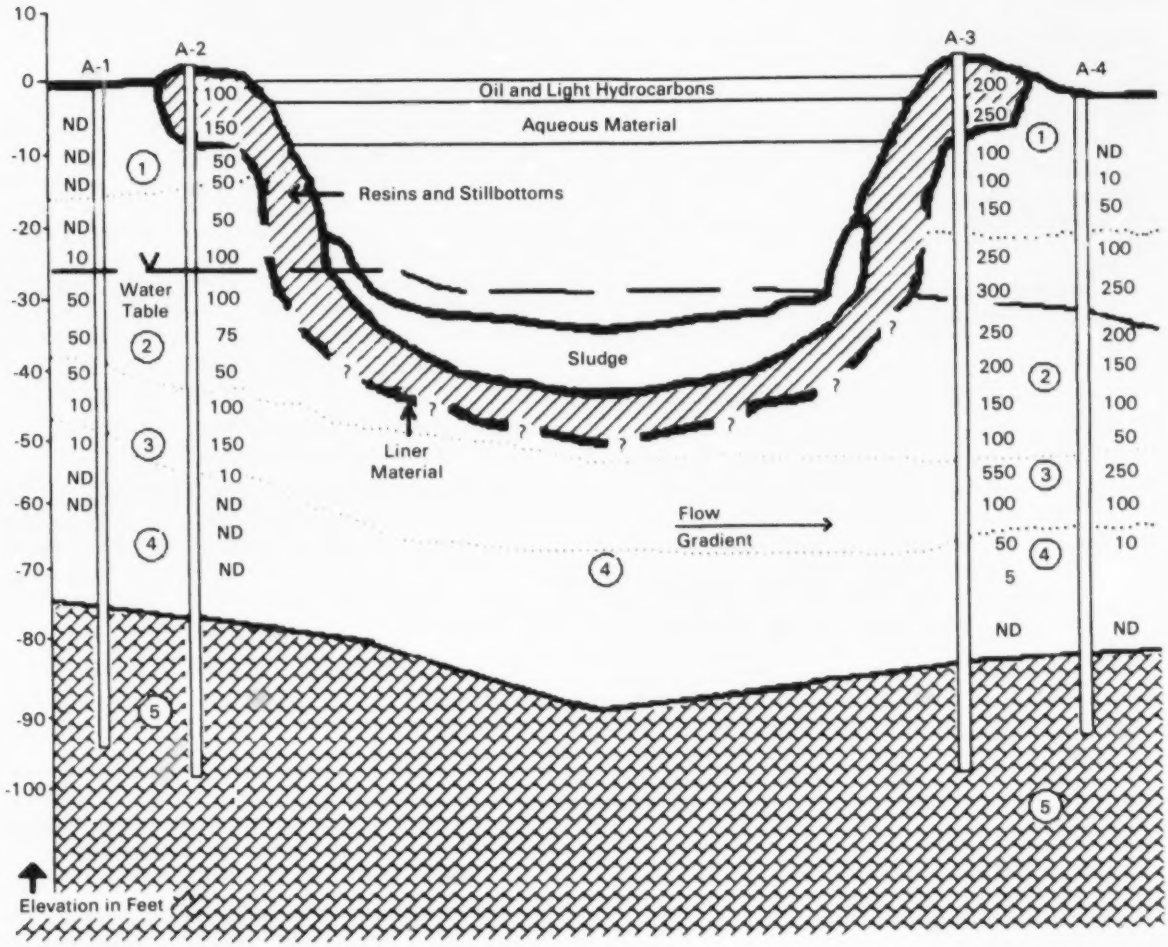
- An objective evaluation of the goals both of the site visit and the remedial action
- An evaluation of site specific hazards, including airborne contaminants; potential radiological exposure; dermal hazards; hazards due to falls, electrical shock or other traumatic injury; hazards from heavy equipment operation, enclosed space entry, heat stress, etc.
- Medical monitoring of personnel going on site.
- Delineation of contaminated, decontaminated, and clean zones
- If tanks are to be surveyed, specific protocol must be included describing access procedures, how personnel are to open and check tanks, and how worker safety will be ensured if tank structural integrity is uncertain.
- A description of site conditions including the characteristics of the surface impoundment, and the nature of wastes on-site
- Contingency plan for emergency action (e.g., include telephone numbers and locations of local hospitals, fire departments, and police etc.)
- Training required.

The user is referred to the *Occupational Safety and Health Guidance Manual for Superfund Activities* (NIOSH, 1984), *Guidance on Remedial Investigations Under CERCLA* (EPA, 1985) and *Standard Operating Safety Guides* (EPA, 1984) for additional information.

Limitations

If only limited data describing the potential hazard level on site are available, the health and safety guidance may be excessively conservative or inadequate to protect workers. Any existing data or past

Figure 4-3. Typical soil/geologic cross section of surface impoundment and adjacent area.



(1)—Loam, organic material with silt and clayey layers locally

(2)—Gray and brown silt and trace fine sand

(3)—Fine to coarse sand with gravel

(4)—Glacial till, clay and weathered shale

(5)—Bedrock, refusal

Note: Number values represent total organic vapor content as measured by OVA headspace analysis (ppm) as influenced by soil structure and permeability.

health and safety plans should be field verified prior to adoption.

4.2.4 Prepare Community Relations Plan

Purpose

A community relations plan is a prerequisite for remedial actions at NPL sites because of their high public visibility and public interest. The purpose of a community relations plan is to keep the public aware of plans and activities related to the site and to receive input from the community regarding the site.

Techniques

This community relations plan includes: a site description; history of community relations activities; discussion of key parties and their concerns; the site specific community relations objectives; communication methods; a staffing and budget plan; a site mailing list; and work schedule. Further guidance on these activities is provided in *Community Relations in Superfund: A Handbook, Interim Version* (EPA, 1983).

Limitations

Not applicable.

4.2.5 Identify Potential Remedial Action Technologies

Purpose

This activity plays an important role in the development of the remedial evaluation and provides the basis to determine if existing data are adequate to support proceeding directly to limited FS. A preliminary list of applicable technologies is also prepared so that during the initial site characterization, any obvious limitations to a specific alternative can be identified. While this step occurs in the RI phase, it is actually the initial activity of the limited FS phase. This overlap in phases helps to expedite the schedule, but more importantly, improves the usefulness of data generated in the limited RI.

Techniques

Potential remedial technologies applicable to surface impoundment sites can be identified by performing the following three-step process:

1. Use existing references and documents concerning remedial activities for surface impoundments and waste characteristics to compile a list of remedial technologies that could be applicable to the physical setting and waste characteristics at the site.

2. Screen out technologies that are not likely to be feasible on the basis of a broad-perspective review of the constraints of implementation of each technology for site conditions. This screening should consider compatibility of technologies, timing of implementation, environmental impacts, regulatory requirements, and relative costs. The analysis will require substantial use of best engineering judgment.

3. The remedial technologies that may be implementable will serve as the basis for determining subsequent data needs. The limited RI should concentrate on obtaining the data needed to adequately analyze the feasibility of these technologies, alone and in combination as remedial alternatives, during the limited FS.

An important part of the process of identifying potential remedial technologies for surface impoundments is to review the logical steps involved in remedial action for a surface impoundment. A diagram of these steps is shown in Figure 4-4. From this logic diagram, and using available references and documents concerning remedial activities for surface impoundments, a matrix of potential technologies and waste categories can be developed. Best engineering judgment may be necessary to resolve issues for which there are insufficient existing data regarding the physical setting and waste characteristics.

Sufficient existing data may be available to determine if some on-site alternatives, particularly related to disposal, can be eliminated. For example, secure land burial, if the site is a wetland area or in a floodplain, may not be a feasible or environmentally sound alternative. The importance of beginning the identification of technologies and initial screening during the limited RI is twofold. First, technologies are reviewed and screened with regard to the documented physical setting and waste characteristics at the site. Secondly, it allows data collection activities to include assembly of information useful in the further evaluation of remedial actions.

Limitations

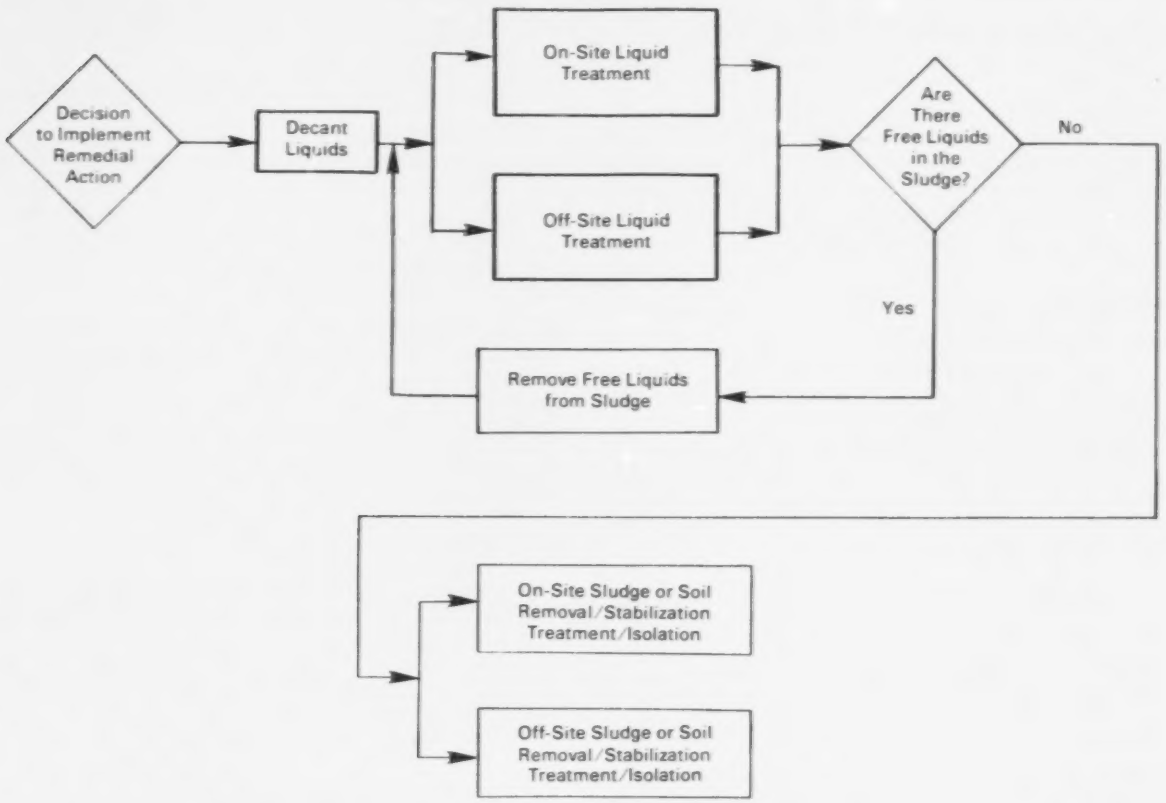
Limited data may make selective identification of potential remedial technologies difficult.

4.3 Perform Initial Site Characterization

The initial site characterization is an important transitional activity which is centered around an initial site visit. The limited RI progresses from activities that are based upon existing data to activities and decision points which use information developed from initial field activities. The principal activities in initial site characterization include:

- Performing an initial site visit (Section 4.3.1)
- Determining if conditions could result in an im-

Figure 4-4. Surface Impoundment Remedial Action Logic Diagram



mediate threat to human health and/or the environment (Section 4.3.2)

- Conducting a preliminary exposure assessment so the scope of the limited RI/FS can be evaluated (Section 4.3.3)
- Determining the need for continued limited activity based upon review of additional information (Section 4.3.4)
- Defining the data requirements for conducting the limited FS (Section 4.3.5)

4.3.1 Conduct Initial Site Visit

Purpose

The purpose of this activity is to:

- Verify existing data (e.g., surface impoundment conditions, freeboard conditions, extent of dike erosion)
- Identify critical areas on-site (e.g., possible equipment staging areas)
- Visually characterize wastes (e.g., stratification, nature, physical state)
- Gather additional data to support further site evaluation (e.g., soils stains, areas where spills have occurred)

Techniques

After all the preparatory activities described in Section 4.2 have been completed, the user is ready to enter the surface impoundment site for the initial site visit. While on-site, the provisions of the initial site health and safety guide must be strictly observed. Furthermore, if anything unanticipated in the health and safety guide happens, discontinue on-site activities and re-evaluate the situation.

The potential hazards associated with volatilization of some organic compounds will be assessed utilizing a portable organic vapor analyzer (OVA), commercially available photoionizer, or photovac GC. Indicator tube sampling can also be used to provide qualitative information, which is important input to the design of the site safety program. The sample team monitors ambient air for the specific compounds identified in preliminary information to determine whether an imminent health hazard exists.

The initial site visit may only involve limited sampling.

The following activities may be performed during the initial site visit:

- Identification of unusual features, including
  - —spill areas and stained soils
  - —evidence of environmental stress to flora or fauna
  - —presence of wastes requiring special handling or precautions
  - —presence of wastes other than those in the surface impoundments
- Examination of surface impoundments, including
  - —amount of dike erosion, evidence of dike instability, seepage through dikes
  - —freeboard conditions and site features that could result in changes to liquid levels
  - —details of impoundment construction such as dike composition or nature of liners
  - —condition of piping and other interconnections between impoundments
  - —factors affecting the accessibility of impoundments to heavy equipment such as moisture content of soils and width of dike crest
- Field characterization of wastes, including
  - —presence of stratification in the impoundment, impoundment depth, and the thicknesses of various waste layers
  - —general nature of wastes—whether oily or aqueous
  - —the physical state of the wastes—whether scum/floating sludge, liquid, semi-solid sludge, or solid
  - —physical properties of the wastes such as color, viscosity, or texture
  - —chemical properties of the wastes such as organic or inorganic
  - —ambient vapor conditions at various distances with respect to open impoundments
- Identify:
  - —Site utilities, facilities and structures
  - —Unusual wastes (lab pack, cylinder)
  - —Drainage
  - —Spills, seeps, etc.
  - —Divide site into zones to facilitate identification of target areas and future remedial actions
- Make preliminary inventory of any waste surface impoundments and drums/tanks that may be on site
- Locate access, egress, and security points
- Note evident environmental stress
- Perform air quality monitoring
- Interview local residents
- Identify staging and access areas
- Identify and confirm features on the preliminary base map and soil/geologic cross section
- Photograph or videotape site features

It is not unusual for abandoned impoundments to overflow, resulting in overland movement of wastes. If contaminated soils are high in volume, or are found at any substantial distance from the impoundment, the inclusion of a second operable unit study or the move to a full RI/FS activities may be required. If surface water bodies are involved in the overflow event, observations of gross sediment contamination or environmental stress should include these areas.

All contaminated soil target areas in the vicinity of the surface impoundment should be located and described. A typical contaminated soil target inventory form is present in Table 4-1.

Table 4-1. Example of a Completed Contaminated Soil Target Area Inventory Form

	Target Area	
	A	B
Approximate Extent of Area Contamination	.25 Acre	.10 Acre
Field Instrument Reading	.250 ppm	ND
Sludge Piles	Yes	No
Above Ground Tanks or Drums	No	No
Barren (Sparsely Vegetated) Area	Yes	Yes
Evidence of Soil Disturbance (Landfilling)	No	No
Seepage Basins/Lagoons	No	No
Evidence of Dumping/Spills (Tire markings or eroded soil)	Yes	Yes
Evidence of Buried Drums (Geophysical methods)	No	No
Other Visible Evidence (Explain)	None	Near chemical transfer facility some spillage occurs during normal operation
Possible Contaminants	Solvents	Acids, petroleum

Detailed examination of the surface impoundments is important for several reasons. Observation of dike erosion, incipient instability, or seepage may indicate the need for actions to mitigate an immediate hazard. Similarly, immediate hazards may be posed by limited/inadequate freeboard conditions or impoundments receiving stormwater runoff. Details of impoundment construction (such as whether the dikes are composed of on-site soils or the presence and condition of a liner) will be useful in estimating or measuring waste volumes and may affect the feasibility of remedial technologies. Severly deteriorated piping could become a pathway for sudden releases of waste material. The feasibility of remedial technologies that use heavy equipment can be substantially affected by soft ground or other conditions limiting access to the impoundments.

Characterization of waste materials by visual observation and direct-reading instruments is also very important. Identification of stratification within the wastes is necessary for representative sampling, while total impoundment depth and layer thicknesses are needed for determining waste volumes. The physical and chemical characteristics of the wastes are clearly key variables in defining alternative technologies for source control action and in identifying the most cost-effective actions, if needed.

A limited geophysical survey may be performed to identify subsurface hazards such as buried drums, tanks and semi-solid wastes. These hazards may limit further field work such as drilling of soil borings for collection of subsurface samples until the degree of hazard could be assessed and/or removed. Geophysical methods that could be employed include ground penetrating radar, magnetics, resistivity and electromagnetics (terrain conductivity). The general applicability of each of these techniques for detecting subsurface hazards is shown in Table 4-2.

Special wastes (radioactive, gas, etc.) not associated with the surface impoundments may also be present at the site and should be noted during the site visit. Laboratory packs (drums, cans or boxes containing laboratory wastes) may also hold hazardous wastes. More commonly, however, lab packs hold small containers of often incompatible materials.

A higher level of health risk to the inspection team is associated with the disturbance or handling of special types of wastes. If any special wastes are observed on-site, assistance from trained, experienced personnel who are specialists in dealing with these types of wastes should be obtained before attempting to evaluate them.

Limitations

During the initial site visit, little sampling may be performed and only preliminary on-site activities may be performed, limiting the certainty of information.

4.3.2 Determine if an Immediate Threat Exists

Purpose

The primary purpose of this activity is to determine if an immediate threat to human health or the environment exists. The most common immediate threat would be the release of hazardous wastes due to the failure of a dike or a surface impoundment.

Technique

The following physical conditions justify special and immediate attention:

- The absence of fencing or other measures to prevent direct contact between the public and hazardous materials in or around the surface impoundments
- The presence of flammable or explosive materials in situations making fire or explosion possible or probable

Table 4-2. Application of Geophysical Techniques to Detection of Subsurface Hazards

Method	Advantage	Disadvantage
Ground Penetrating Radar	Gives best depth estimate	Depth penetration can be greatly reduced by near surface clays, and other highly conductive mediums (e.g., scrap metals); most expensive method
Magnetics	Fast, inexpensive	Sensitive to cultural interference; e.g., powerlines, pipelines and buildings
Resistivity	Can sample discrete increments of subsurface materials	Considerably slower than the other methods listed and perhaps less sensitive to buried drums
Electromagnetics (terrain conductivity)	Fast, inexpensive	Sensitive to cultural interference, e.g., powerlines, buried pipelines and buildings

- Severely degraded waste storage facilities, such as excessively eroded or badly seeping dikes, that would result in sudden and/or widespread releases of large amounts of hazardous materials
- Limited or inadequate freeboard conditions with heavy rainfall likely or with surface drainage directed into the surface impoundments
- Air releases above acceptable levels as measured by direct reading instruments or other air quality monitoring devices

The presence of one or more of these conditions does not necessarily mean there is a significant immediate threat to human heath or environment. Other factors should be considered, such as types of waste materials in the impoundment, location and exposure routes to sensitive/human receptors, and existing topographic and physical features near the site.

If an immediate threat is observed during the initial site visit, after all factors have been considered, the agency responsible for site activities and possibly the National Response Center [Telephone (800) 424-8802] should be contacted.

Limitations

If uncertain of the nature and significance of the threat, contact the agency responsible for site activities and evaluate the situation with them before contacting the National Response Center. The focus at this point is defining and reducing very eminent and obviously dangerous conditions.

4.3.3 Conduct Preliminary Exposure Assessment

Purpose

The level of hazard posed by the site is assessed for each of the identified receptors, and the need for further action is determined. This assessment will be used and further evaluated during the limited FS to determine if a no action alternative is appropriate.

Techniques

The following steps may be used to perform this preliminary assessment:

- Identify and characterize each waste source (type of waste in each impoundment).
- Identify and observe the conditions of dikes/liners and freeboard.
- Identify the actual or potential pathways of contaminant migration for each waste source (surface water, ground water, air transport, or combinations of the above which could result in direct contact).
- Identify potential public and environmental receptors of the migrating contamination (nearby residents, water wells, wetlands, endangered species).
- Determine if a remedial action is necessary to mitigate the threat to human health or the environment.

An example of these steps is summarized in a matrix in Table 4-3.

Evaluation of the actual or potential threat may include a qualitative or quantitative evaluation of conditions such as the likelihood of migration, amount of contaminant migration, and time frame of the exposure.

(The user is referenced to Agency guidance on risk assessment procedures such as the *Draft Superfund Health Assessment Manual* [EPA, 1985].)

Limitations

Data available at this stage of the investigation may allow only a very cursory assessment of exposure and threats to public health and the environment.

4.3.4 Determine Need for Continued Limited Activity

Purpose

The decision to conduct a limited RI/FS for surface impoundments should be re-evaluated in light of the detailed review of data and the initial site visit. While the basic objectives of a limited RI/FS may still be valid, it may be more appropriate to expand the scope to include other contaminated media found on site (e.g., soils). The cost-effectiveness of a focused fast-track surface impoundment project must be compared with the value of integrating the surface impoundment portion into the overall site RI/FS.

Techniques

Criteria for making a decision on whether to continue a limited RI/FS for surface impoundments or to expand the scope to include the entire site will obviously vary depending upon site-specific conditions. Some areas which should be focused upon are summarized below:

Public Health and Environmental Risk. Would fast-track handling of surface impoundment waste significantly reduce potential public health and environmental risk?

Cost-Effectiveness. Based upon new information, is there a potential for implementing a reme-

Table 4-3. Example of a Completed Matrix of Exposure Assessment Activities

Waste Characteristics	Sources			
	Pit 1	Pit 2	Pond 1	Lagoon 1
Acid		L/S		S
Base			L/S	
Inorganic		L/S	L/S	
Organic	L/S			L/S
Solvents	L			L
PCB's	S			
Sulfides		S		
Cyanides			L/S	
Halogenated	L/S			
Integrity of Retaining Structures*				
High	X			
Medium			X	
Low		X		X
	Migration Pathways			
Ground Water		A	P	P
Surface Water	P	P	P	A
Air	A			
Direct Contact	P	A		P
	Receptors			
Residents	A	A		P
Wells		P	P	P
Wetlands	P	P	P	A

S = Applies to sludge phases; L = Applies to liquid phases
A = Actual pathway/receptor; P = Potential pathway/receptor

*This evaluation relates specifically to berm/dike stability available, free board and the presence of seeps or breaches.

dial program for the entire site on a more cost-effective basis than a limited approach?

Schedule. Does new information show that the schedule for implementing a limited remedial action would not differ much from that of a larger scale action?

Limitations

In deciding whether to expand the scope of the limited RI, the types of remedial technologies involved with handling the different contaminated areas on-site must be considered. In many cases, the remedial technologies for buried wastes, waste piles and waste spills (contaminated soil and water) are different than those for surface impoundment wastes. Where these different types of wastes are present, the combination of remedial technologies may be difficult and may not be cost effective. However, wastes contained in surface impoundments may be similar or related to wastes in tanks and drums on the same site. Previous operators of the site may have used the surface impoundments to hold certain waste residues removed from the tanks and/or drums, or may have used impoundments as an intermediate step in a waste reclamation process. In cases such as these, it may prove cost effective to combine remedial technologies for the similar types of wastes.

In very unique circumstances, it may be possible to discontinue the limited RI/FS. For exmple, if the preliminary assessment indicates that migration and/or significant exposure from hazardous materials from surface impoundments cannot be reasonably expected in the short term, the limited RI may be discontinued and the operable unit evaluated with the other contaminated areas of the site. Another reason for discontinuing evaluation would be if the surface impoundment is reasonably determined to be of no threat to public health and the environment in the short and long term.

4.3.5 Define Data Needed to Conduct Limited Feasibility Study

Purpose

The data needed to evaluate the feasibility of potential remedial alternatives (identified previously) are compared with the data collected up to this point in the limited RI. If the limited RI data base is sufficient to conduct the feasibility study, the final component of the limited RI can be omitted and the limited FS initiated directly. If there are deficiencies in the data base which would restrict the performance of the limited FS, then additional data will be required.

Techniques

The types of data needed to evaluate remedial technologies are often described in existing reference documents. A summary of data needs can be prepared for techniques applicable to surface impoundment remedial actions. Table 4-4 presents a list of data needs for evaluation of on-site disposal and/or treatment of surface impoundment wastes. This type of information would be useful for many components of the limited FS (e.g., developing costs and design evaluation criteria). If treatment options are being considered, the applicability of various technologies to the site-specific waste characteristics should be reviewed.

Comparison of the data needs with the existing data base will identify any data gaps. The data gaps for each of the technologies should be consolidated into a master list and then evaluated for significance of the missing data. Although certain data may not be directly available, it is often possible to estimate certain parameters or quantities without compromising the validity of a feasibility evaluation.

Limitations

Not applicable.

Table 4-4. Examples of Data Needs for Evaluation of Potential Remediation Activities

- Is the site located in the 100-year floodplain?
- Is the site located within 200 feet of a fault which has had displacement in recent geologic history?
- Does ground water under the site have a rapid rate of travel (i.e. greater than 100 feet per 100 years)?
- Is the site in a wetland?
- Is the site in area with karst, subsidence, or landslide activity?
- Is the depth to the seasonally high ground water elevation beneath the site relatively shallow (i.e., less than 10 feet)?
- Is the ground water beneath the site used for individual or municipal water supply?
- Is the site topography relatively steep (i.e., greater than 30 percent)?
- Is the site located in the vicinity of a surface water body or a ground water recharge area?
- Have springs or seeps been identified in the area of the site?
- Has underground mining previously been performed in the vicinity of the site?
- Is the site located in an area with weak and unstable soils?
- Is the hydraulic conductivity of the bedrock beneath the site relatively high (e.g., as would be expected within a sandstone or fractured zone)?
- Is the site located in close proximity to a residence, school, hospital, commercial area, or other sensitive receptors?
- Is an adequater buffer zone present around the site?
- Is the site located in close proximity to a public water supply (e.g., reservoirs, watersheds, or supply lines)?
- Are there unique and protected land uses adjacent to the site (e.g., parks, historic sites, etc.)?

4.4 Conduct Detailed Field Investigation

Once potential remedial technologies have been developed and data gaps defined, a limited field investigation is performed to gather the required data to evaluate the technologies. The following steps can be followed for the final stage of the limited RI.

4.4.1 Prepare Project Operations Plans

Purpose

Prior to beginning on-site elements of the limited RI, certain planning preparation must be completed. The development of project operations plans will assist the user in initiating the limited RI, performing the limited RI in a safe and effective manner, and in being prepared for emergency situations, should they arise.

Techniques

The major components of a project operations plan include a sampling plan and a health and safety plan. In addition, a quality assurance/quality control (QA/QC) plan may be included as part of the project operations plan or as a separate document. Normally, a quality assurance plan is formulated outside of the project operations plan and quality control is addressed within the project operations plan.

4.4.1.1 Sampling Plan

A sampling plan is developed to describe what data will be obtained, what sampling will be performed, and how these tasks will be completed. The plan is then reviewed by all involved parties to ensure that data requirements will be met and that the data will be collected in a proper and effective manner.

It is important to define specific objectives of the sampling program in the plan. How data will be used in the limited FS should be indicated. Also, the waste categories to be analyzed will be clearly defined with a description of the relationship of these categories to the limited FS and project implementation activities.

Many guidance documents exist for preparing a sampling plan (see Section 6.0), and sampling plans used for completed projects are good models. A typical plan for a surface impoundment site would address the following topics:

- Goals of sampling effort
- Use of sampling data (to select treatment or disposal options)
- Types of surveys to be performed (geophysical surveys, detailed site mapping, air monitoring, etc.)
- Number and type of samples (supernatant, sludge, ground water, surface water, soils, dikes) and constituents for analysis
- Sample analyses/compatibility testing (organic/inorganic, reactivity, flash point, halogen content, PCB, cyanide, sulfide, etc.)
- Methodology describing sampling procedures

The characterization of types of wastes on-site may be used to prepare design reports, feasibility studies, cost estimates for cleanup, and contract documents.

When developing a sampling plan, consideration should be given to field screening techniques and the use of composite samples. Both approaches provide a means for obtaining needed data without extensive laboratory analysis and its associated costs. Field screening of samples, for example, using organic vapor detectors to assess volatile organic compounds or pH papers/meters to assess corrosivity, can be used in several ways. It can be

used to identify those samples likely to have the highest contaminant concentrations, which can then be sent to the laboratory for quantitative confirmation. It can also be used to identify concentration gradients, the extent to which contaminants are attenuated with distance from the source, both horizontally and vertically. In this situation, samples from either side of the suspected boundary are sent to the laboratory instead of sending all samples collected and determining the boundary later. Composite samples can be used to obtain an overall indication of contaminant concentrations in situations where spatial variation is not likely, for example, within liquid phase contained in an impoundment. Because this approach averages concentrations, it is not applicable to determining maximum concentration gradients or detecting contamination boundaries.

Methods of implementing components of the soil/subsurface sampling and exploration plan, including reconnaissance, sampling boring, logging and handling of samples are discussed below. This information is intended as a brief overview of commonly used methods with respect to their applicability to hazardous waste investigations, and is not to be substituted for comprehensive procedures.

- Reconnaissance methods

  Site reconnaissance is useful in obtaining qualitative information about site facilities and processes, topography, potential problems pertaining to access of equipment and location of monitoring wells, borings and sampling stations. This allows necessary modifications in the sampling plan to be made before the contractors and sampling personnel arrive on site.

  Visual observations, hand sketches, and photographs comprise the primary means of recording data. In addition, if a high hazard exists, radio transmitters, blackboards and hand signals may be useful for communication between site personnel.

  Elevation and boundary surveys may also be useful in establishing control points for mapping locations of proposed site activities.

- Surficial soil sampling methodologies

  Samples of surficial materials are collected for analysis in order to provide data regarding the extent of contaminant migration as a result of: (1) transport of contaminated sediments and/or (2) the absorption or reactivity (e.g., cation exchange capacity) of contaminants with surficial materials, and/or (3) the general chemical or physical nature of the surface sediments. Analysis of surface soil and sediment samples may serve to confirm or compliment data obtained from analysis of surface waters.

  Collection of surficial samples may not require special sampling equipment other than properly cleaned hand-held tools (i.e., shovels, trowels, plastic spoons) or may require backhoes and boring equipment. Samples may be obtained on or in the vicinity of a hazardous waste site and should be representative of the nature of local surface soils or sediment.

Limitations

When sampling is not adequate to develop and evaluate alternatives and cost estimates (+50/−30 percent), the selection of remedial activities may be delayed.

Penetration of lined or sealed bottoms of surface impoundments is an issue of concern when sampling is needed to determine bottom sludge thicknesses and the extent of grossly contaminated soils. If there is obvious leakage from the impoundment, penetration of the bottom layers during sampling would probably not be a problem. In certain cases, sampling may have to be planned to occur in two phases, the second phase beginning after impoundment surface water removal.

The sampling plan would not be designed to collect data for alternative actions that were determined to be infeasible based on site conditions (see Section 4.2.5). Screening activities to this point would eliminate those remedial technologies which appear least feasible and reasonable.

The user should be aware that field analysis of samples may not produce the litigation-quality documentation available through a laboratory. Instead, field analysis can be used to develop information to proceed with the project while a small percentage (e.g., 25 percent) of the samples are sent to a laboratory for analysis and verification. Additionally, field screening techniques are of limited value in complex samples (e.g., oily sludges) and are not available for all contaminants. For example, few field instruments measure inorganics; however, some ion specific probes are available. Additionally, because of the concentrated nature of these samples, a laboratory equipped to handle such high-hazard samples (such as EPA's hazard laboratory at NEIC) may be required.

4.4.1.2 Health and Safety Plan

A health and safety plan is developed to establish the procedures that will be followed during the execution of the detailed field investigation. This plan is developed from earlier health and safety protocols (See Section 4.2.3) and information assembled

from activities such as the initial site visit (Section 4.3.1). EPA's detailed guidance on health and safety can be found in *Standard Operating Safety Guides* (EPA, 1984).

To confirm the basis for the site worker respiratory protection protocol contained in the health and safety plan, both on- and off-site air quality monitoring should be initiated at the onset of the project mobilization and maintained during on-site activities. Additionally, due to the nature of waste materials often found in surface impoundments and their ability to rapidly degrade ambient air quality, it is important to continue air monitoring both on- and off-site during the limited RI so that potential impacts from handling wastes can be evaluated.

A specific air monitoring program must be established for each site based on the nature of the wastes present on-site and site conditions. Sampling may be performed for organics (volatile compounds), inorganics (cyanide gas), or airborne particulate (asbestos). Methods currently used to monitor air quality at surface impoundment sites include:

- Direct reading methods
  —Organic Vapor Analyzer (OVA)
  —Photoionization detector
  —Photovac GC
  —Infrared gas monitors
  —Explosive gas indicator
- Delayed quantification techniques
  —Collection of samples using air sampling pump and sorbent charcoal, glass filters, or other media.

Other components of the health and safety plan should include a training program (for surface impoundment sampling), contingency plan, and guidance on area and access restrictions.

4.4.1.3 Quality Assurance/Quality Control Plan

A quality assurance plan is an assemblage of management policies, objectives, principles, and general procedures to be followed in producing environmental monitoring data of known and acceptable quality. Quality control refers to the routine activities and checks, such as calibration and duplicate analysis, conducted under the quality assurance program.

EPA's guidance on preparing quality assurance plans is found in *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (EPA, 1983). The sixteen components of a quality assurance plan according to the EPA guidance are:

1. Title page with provision for approval signatures
2. Table of contents
3. Project description
4. Project organization and responsibility
5. QA objectives for measurement data in terms of precision, accuracy, completeness, representativeness, and compatability
6. Sample procedures
7. Sample custody
8. Calibration procedures and frequency
9. Analytical procedures
10. Data reduction, validation and reporting
11. Internal quality control checks
12. Performance and system audits
13. Preventive maintenance
14. Specific routine procedures to assess data precision, accuracy and completeness
15. Corrective action
16. Quality assurance reports to management

Some of these components of the quality assurance plans are actually quality control procedures. For example, the "Calibration Procedures and Frequency" section of the QA plan may merely refer to the applicable standard operating procedure (quality control) found in the sampling plan or health and safety plan.

4.4.2 Conduct Impoundment Investigation

Purpose

The purpose of this investigation is to collect data concerning the surface impoundments and the contained wastes needed to conduct the limited FS. The scope of this investigation may include further assessment of impoundment stability and other structures if potential problems were identified during previous site visits. At a minimum, the investigation must include measurement or estimation of waste quantities, and sampling and characterization, both physically and chemically, of *all* waste phases.

Techniques

Dike Stability. Investigation of potential dike stability should be done if it appears that failure could occur before or during implementation of the remedial action. The basis for identifying potential instability include ongoing seepage of liquid wastes through the dikes, sagging along the crest of the dike, or evidence of incipient failure such as slumps, sags and tension cracks in the outer face of the dike.

Investigations should be undertaken using standard geotechnical techniques and analyses. These include exploratory boring with Standard Penetration Tests and the collection of undisturbed samples; and laboratory testing of index properties (moisture content, Atterberg limits, grain-size distribution) and engineering properties (unconfined compression, consolidated-undrained triaxial, consolidation/settlement). Borings would be needed in and/or adjacent to potential failure areas, preferably through the crest of the dike to a depth equal to twice the height of the dike. (Note: Caution must be used when boring at an uncontrolled site due to activities that may cause excessive soil movement.) The final determination of stability should be made using generally accepted slope stability analytical methods such as Bishop's method, or the method of slices.

Measurement/Estimation of Waste Quantities. Measurement or estimation of waste quantities is clearly fundamental to the evaluation of applicable technology. In all cases, an attempt to measure waste volumes should be made first, and estimation used only when direct measurement is not possible (the volume of contaminated soil beneath the impoundment, for example). In addition, every effort should be made to quantify each phase of waste separately.

It will first be necessary to establish some means of accurately locating all measurements/samples taken within the impoundment. If the area of the impoundment is about one acre or less, due to ease of access, it will generally be sufficient to divide the impoundment into a grid system (50 ft. centers). This can be accomplished with two orthogonal control lines, one parallel to the long axis of the impoundment, the other positioned to produce a grid of roughly equal surface area. Control stakes are recommended at each end of the control lines. If the impoundment is relatively small, it may be possible to mark the lines with string or light rope; otherwise it will be necessary to determine locations along the lines or within the grid with a compass and range-finder. By measuring waste thicknesses along the control lines, two profiles of the impoundment can be obtained and the waste volumes calculated. It is recommended that 10 measurement points be evenly distributed along the lines, with spacing of not less than 5 feet and not greater than 50 feet. If the area of the impoundment is greater than one acre, the impoundment should be divided into sections of not more than one quarter acre.

Methods for measuring the thicknesses of liquid waste phases can be grouped into two categories, those allowing identification of multiple phases and those providing only total thickness. Identification of multiple phases is possible using thief samplers (e.g., 3/8-inch to 5/8-inch diameter thick-walled glass tubes), Bacon Bombs (used for bottom sampling), and "strip rods", a measuring device developed by the oil and gas industry that uses special sounding rods to indicate various chemicals colorimetrically. The thief sampler has the advantage of recovering samples from which the physical properties can be estimated. (Early identification of waste properties may be important in selecting the best device for obtaining representative samples.) Methods that provide only total thickness measurements include weighted sounding tapes and ordinary, graduated sounding rods.

Measurement of sludge and solid phase thicknesses generally involves the use of rigid probes that are pushed or driven through these phases to refusal. Care must be exercised because these methods could compromise the integrity of impoundment liners, particularly synthetic membrane liners, or penetrate a gas pocket. At a site in Pennsylvania, remedial action implementation had to be halted when it was found that what was thought to be bedrock forming the bottom of a lagoon was actually a bauxite crust layer. This layer was penetrated, releasing hydrogen sulfide gas. Sampling may be extended as deep as possible in situations where it is known that there is no liner and/or the impoundment is leaking or that a gas pocket is unlikely.

In general, probes should be pushed by hand first, and the depth of initial refusal noted. However, the point must be made that such a sampling procedure requires the assurance that the probe may also be removed. Then, if the probe is strong enough, it should be driven (hydraulically, by vibration, or with a hammer) and the depth of final refusal noted. Hollow pipes and conduits used as probes have the advantage of allowing identification of layering or multiple phase, and providing samples for estimating physical properties. Ideally these probes would have split barrels, but material that could be readily cut with a hacksaw would work just as well. However, such materials may not have the strength to be driven into tarry sludges or stiff solids. Solid probes, which would be better able to withstand driving in difficult materials, can be used to determine total thicknesses.

Although it will generally be possible to measure the thickness of liquid phases in impoundments, it may be more difficult to physically measure the sludge and solid phases, particularly at the bottom of the surface impoundment. In such cases, it may be possible to quantify the volume of these phases by estimating the total volume of the impoundment and subtracting the volume of the liquid phases. Methods for estimating total impoundment vol-

umes may also be applied in situations where the health and safety hazards are significant. Total impoundment volumes can be estimated by several methods:

- Projection of topographic trends—applicable to situations where the impoundment was created by closing off low spots, swales or valleys
- Identification of depth-limiting features—if bedrock is relatively shallow; it may be reasonable to assume that the bottom of the impoundment is not below the top of rock
- Evaluation of cut/fill balance—applicable to situations where the encircling dikes were probably constructed from material excavated to create the impoundment

Whenever possible, direct measurement is the preferable approach for developing volume estimates and should be attempted before indirect methods are used.

Sampling/Characterizing Waste Phases. Samples for the purposes of physically and chemically characterizing the waste phases present in an impoundment should be taken at the center of each quadrant defined by the control lines established above, from any operating inlets, and immediately adjacent to any inoperative inlets, outlets, and overflows. This will provide a general characterization of the impoundment contents while allowing detection of spatial variations caused by differential settlement of entering solids. Drill rigs are restricted to solid ground, access to impoundment sampling location can be accomplished by remote/on-shore methods, such as "cherry pickers" (restricted by 25 ft reach) and platforms suspended from cranes, (restricted by 100 ft reach) or by on-site/off-shore methods, such as flat-bottomed boats and rafts. In either case, the selection of sampling access should consider both the safety of the workers and the stability of the working area.

In general, sampling equipment should be disposable or readily decontaminated. Whether a sampling device is readily decontaminated will depend in part on the characteristics of the wastes being sampled. Sampling should proceed from "clean to dirty", particularly when many samples will be taken with the same piece of equipment; in practice this generally means "from the surface down". The sampling equipment selected for the various phases will depend on the properties of the target phase and the quantity needed for analysis. The quantity needed for analysis will depend on the kind of testing to be done.

Prior to actually obtaining samples at each sampling location, the presence and thickness of the waste phases should be verified. This can be accomplished using the methods and techniques described above for measuring waste thicknesses. Depending on the quantity of sample needed, it may be possible to combine the verification of phases with sample collection. For example, if the quantities of liquids needed are relatively small, a thief sampler could be used. The continuous sample obtained using a hollow conduit to identify sludge and solid phases may provide enough material for the required testing of these phases.

Floating scum and sludges can be efficiently sampled using a common kitchen strainer, preferably made of stainless steel. This sampler would be easy to decontaminate and could be fitted with a telescoping or extension handle as needed. Liquid phases can be sampled with several devices. Surface samples can be collected in open vessels (beakers, bottles, etc.). Thief samplers, which are disposable, provide samples of the entire liquid column; but they do not work well for viscous or tarry liquids, and the sampled volume is relatively small. Depth-specific samples can be obtained with double check-valve samplers such as Kemmerer devices.

Sampling of sludge and solid phases can be done with a variety of thin-walled tube samplers or with auger devices. Examples of thin-walled tubes include standard Shelby tubes, piston corers, and continuous conduit/casing. The Shelby tube is only three feet long, and casing would be needed to maintain an open hole if more than one depth interval had to be sampled. Piston corers, which have relatively better recovery in soft materials, are available to lengths up to 10 feet, but these larger devices may be unwieldly in some small boats. Other methods for sediment sampling may include the use of a dredge, gravity core sampler, small drag line, alpha sampler, coliwassa sampler, continuous flight auger (hollow stem), or bucket auger.

Physical and chemical characterization of waste phases should concentrate on parameters that will have an operational impact on the handling, treatment, and/or disposal of the waste. Physical characterization of floating sludges and liquids should include density, viscosity, and suspended solids content; and sludges and solids should be characterized for free liquid content (paint filter test), bulk density, percent solids, and slump angle. The extent of chemical characterization and sampling should be discussed with the lead agency.

Limitations

The limitations of sampling methods and chemical characterization methods is beyond the scope of this document.

4.4.3 Conduct Focused Ground Water Investigation

Purpose

The focus of a ground water investigation may vary with site conditions and alternatives being considered and may include the following:

- Determining depth to water table and presence of contamination from the impoundment
- Identifying local ground water flow direction and rate
- Characterizing ground water flow systems

At a minimum, this investigation should address the first purpose listed above. This will answer two important questions—is the impoundment at or below the water table? and is the impoundment leaking? If the impoundment is in contact with the water table and ground water control is part of the remedial action being considered, the second purpose listed above should be addressed. Finally, if on-site alternatives appear to be feasible, the third purpose listed above needs to be included in this investigation.

Techniques

Well Network Design. The number and location of wells needed in the monitoring network will vary as a function of the purpose of the investigation. Determining the depth to the water table requires only one well, which should be located as close to the impoundment as possible. The closest location would be through the crest of the dike; and although this would mean a deeper hole than a well at the toe of the dike, a well located at the crest would be less likely to miss ground water mounding beneath the impoundment. Extremely elongated impoundments might warrant a second hole for this purpose. An additional advantage of positioning a well in close proximity to the lagoon is to assure knowledge of underlying geologic formations.

Detecting the presence of ground water contamination from the impoundment could be done with only one well if no other sources of contamination were present. This well would have to be located down-gradient of the impoundment or within the ground water mound beneath the impoundment. If other sources are present and a good estimate of the ground water flow direction is available, confirmation of leaking could be verified with just two wells—one down-gradient close to the impoundment and one up-gradient far enough away to avoid encountering the ground water mound.

If the impoundment has a liner, especially a synthetic membrane liner, the leak could be very localized. In this situation, it will be easier to detect a plume of contamination at relatively greater distances from the impoundment. The reason for this is that a single well close to the impoundment may be down gradient of the impoundment but not of the leak, whereas a single well at a greater distance has a better chance of being downgradient of both, due to the tendency of plumes to expand in area as they migrate. Thus, it may be necessary to define the local ground water flow direction with on-site well data and then place an additional well in the confirmed down-gradient direction if needed to detect the plume. This approach requires that site soils be relatively permeable and that the impoundment have been in operation for several years; otherwise, the plume will not have dispersed far enough to be readily detected.

Identifying local ground water flow directions and rates requires a minimum of three wells, which should be located in a roughly triangular pattern around the impoundment and far enough away to avoid the ground water mound beneath the impoundment. Water level measurements in the three wells define the slope and orientation of the local water table. Ground water flow will be perpendicular to the equal-elevation contours (equipotentials) on the water table surface. Ground water flow rates are the product of the hydraulic gradient and the permeability divided by the porosity of the soil. The hydraulic gradient is equal to the slope of the water table along a flow line. Permeability can be estimated from grain-size data or the literature; porosity is generally estimated from the literature. Identification of mounding beneath the impoundment would require the addition of one more well to this network. Having data on the vertical flow component and mounding will be useful in any comparison of hydraulic gradients from before and after any remedial activities at a surface impoundment.

Characterizing multi-aquifer ground water flow systems necessitates the use of well nests—two or more adjacent wells with screened intervals at different and non-overlapping depths. A minimum of one nest should be used. If the investigation involves a near-surface (within 30 feet) confined aquifer, the use of three nests is recommended. This will allow the direction and rate of ground water flow in the aquifer to be determined, if installed in a triangular pattern so that hydraulic gradients can be measured.

Well Network Installation. The monitoring well network designed above should be installed in a manner that minimizes the potential for unrepresentative water level readings and samples. Thus, the drilling methods used to create boreholes for the wells should minimize both the disturbance of subsurface materials and the addition of fluids to the

subsurface. Commonly used drilling methods that meet these criteria include hollow-stem augers and wash-rotary with casing advanced ahead of the hole. In either case, it will generally be worthwhile to sample the subsurface materials encountered in the borehole. Sampling of these soil (and rock) materials will provide a basis for estimating or measuring permeabilities and will allow the well design to be "fine-tuned" in the field to meet site-specific conditions. This sampling should make use of both standard split-barrel and thin-walled tube samplers, at a sampling interval of not more than five feet.

The materials used to construct the well should also be chosen so as to minimize unrepresentative data. The well screen and riser casing should be compatible with known contaminants and not introduce any contaminants. For example, no solvent-based cements should be used for PVC casings, nor should galvanized materials be used if dissolved metals are of concern. Two-inch diameter wells will generally be sufficient. After placement of the well itself, careful backfilling of the annular space in the borehole is important. The concern here is to provide for the integrity of the well by completely sealing it off from the surface, or in case of nested wells, from overlying aquifers. In general, there should be a granular media around the screen, an initial seal of bentonite pellets above this, and a cement-bentonite grout placed by tremie pipe from the initial seal to the ground surface. A lockable protective casing should be installed to deter vandalism.

The final part of any well installation is the development of the well. This involves pumping or surging the well in order to create a good hydraulic connection between the subsurface materials and the well. Development is needed for representative samples, especially if a drilling fluid has been used. In this situation, development also has the purpose of purging as much of the drilling fluid from the aquifer as possible. Development can also be used to perform simple field tests, such as rising head or recovery tests, that allow calculation of permeability.

Ground Water Sampling. There are two parts to obtaining ground water samples that have an impact on the representativeness of the resulting data. The first is the purging of standing water from the well. This water generally has a different water quality than the water in the pores of the subsurface materials and it must be removed from the well prior to sampling. As a rule of thumb, between three and five times the volume of water in the well should be purged. Periodic measurement of pH, temperature and specific conductance during purging provides a direct means of verifying that representative ground water is present in the well. Sample collection should utilize methods and equipment that will preserve the integrity of the samples. For example, direct air-lift pumping should not be used if the sample is to be tested for volatile organic compounds, and pumps and bailers should be constructed out of inert materials such as stainless steel or Teflon.

Limitations

The limitations of a ground water investigation are beyond the scope of this document.

4.4.4 Conduct Surficial Soil Investigation

Purpose

This is an investigation that may be undertaken if there is evidence that substantially contaminated soil and sediment are present in the immediate vicinity of an impoundment. The investigation is undertaken to determine if the distribution and concentration of the contaminated materials warrant their inclusion in source control actions taken for the impoundment. Grossly contaminated soils in the immediate vicinity of the impoundment may be included as part of the remedial activities for the surface impoundment operable unit. Any remaining contaminated soils would be addressed under a full RI/FS for the entire site.

Techniques

Basis for initiating study

- Evidence of past or existing dike overtopping, failure or seepage
- Stained soils adjacent to impoundment
- Environmental stress adjacent to impoundment

Scope of study

- Area within close proximity of impoundment (e.g., 50 feet)
- If suspect areas are small, include all in this study

Number and location of samples

- Appropriate number and extent of areas sampled; at least one from each different area/media; even spatial distribution within areas
- If field screening is being used (OVA or pH meter) more samples can be taken
- Composite samples can also be used to reduce number of analyses required

Sampling methods

- Standard methods for surface materials

—Stainless steel trowels and shovels
—Glass and plastic bottles

- Vertical profiling
—Sediment; short piston or thin walled tubes
—Soil; bucket augers and soil probes, test pits

Parameters that may be evaluated as part of the soil characterization field tests include the following:

- Soils slope
- Surface drainage
- Extent of highly contaminated soils
- Field contaminant instrumentation

Determining the extent of soil contamination can be a very time consuming and costly process. It is important to keep the principal focus for conducting any soil sampling in the proper perspective, that is, defining grossly contaminated soil that will be included as part of the surface impoundment operable unit. Waste characteristics, impoundment design and condition, and soil features such as attenuation capacity all have to be considered when selecting parameters useful in defining grossly contaminated soils.

Limitations

The use of field techniques to evaluate the degree of contamination of soil/water systems may be a very difficult task. If volatile organics are present in the system, the use of an OVA or photoionization meter may give an indication of the presence of volatiles. However, the "head space" reading from a sample will be dependent upon time delay after sampling, temperature, seal of lid on sample container, and wind. The results of the "head space" reading are indicative of the presence of contamination by volatiles, but usually do not produce quantitative results.

The use of a field gas chromotograph requires the availability of a power supply with a "clean area," which allows the analysis of samples for particular contaminants rather than a total contaminant level, as with the use of the OVA or photoionization meter.

PCBs in the soils can be detected in the field with a turnaround of approximately one day. However, this requires the use of a field lab set up at the site and generally is a large expense for timely turnaround.

The detection of acids or bases in the soil/waste system can generally be accomplished in the field by the use of litmus paper *or* phenolphthalein (pH 8.3 to 10) and methylorange (pH 3.1 to 4.4).

The use of conductivity of the soil/waste system as compared to background could give an indication of contamination, although the degree of contamination will probably not be a direct correlation.

4.4.5 Conduct an Assessment of Soil-Waste System Characteristics

Purpose

The data generated from soil and subsurface exploration and sampling is used to characterize the soil-waste system so that remedial alternatives which involve the grossly contaminated soils associated with the impoundment can be properly evaluated. Soil properties influence volatilization, leaching potential and attenuation of contaminants. These processes, along with the chemical structure of the compound involved are major considerations in the assessment of impact to receptors (i.e., ground water and air).

Techniques

A discussion of analysis methods for determining attenuation and volatilization of a given contaminant in a soil system is beyond the scope of this document.

Limitations

Due to the complex nature of the soil-waste relationships, an in-depth assessment of soil-waste system characteristics is quite complex and time consuming. Typically the limit of grossly contaminated soils included as part of the impoundment operable unit may not extend much more than three feet beyond the waste material and/or liner of an impoundment.

4.4.6 Review Analytical Results for Conformance with QA/QC Program

Purpose

EPA has developed QA/QC protocol and evaluation methodology to verify the accuracy and reliability of analytical data. The analytical data generated during the limited RI must be examined in accordance with these methods to assure their reliability and subsequent usefulness.

Techniques

Step-by-step QA/QC validation protocol have been developed by EPA (Section 4.4.1).

Limitations

Not applicable

4.4.7 Evaluate All Data and Prepare Limited Remedial Investigation Report

Purpose

The evaluation of data is an ongoing process

throughout the limited RI. However, once all field work has been completed and the data base is essentially complete, a final analysis is conducted. The activities of the limited RI and the results of the data evaluation are then presented in a remedial investigation report. During this final analysis the scope of the limited RI/FS is again reviewed.

Techniques

This evaluation of data should focus on the needs to perform a limited FS. The objectives of various data collection activities are reviewed and then compared to the actual results of the limited RI. It is important to ensure that the data obtained satisfies the earlier defined objectives. If the objectives have been adequately met, the quality of the limited FS, which is based upon data obtained during the limited RI, will be enhanced.

A remedial investigation report on the surface impoundment operable unit should integrate and present a discussion of activities and observations made during the limited RI, and include an evaluation of these data. Detailed discussion of the contents of a full RI report are presented in EPA guidance documents referenced in Section 6.0. A typical report for a surface impoundment site could contain, but is not limited to, the following major elements:

- Site Background Information
- Nature and Extent of Problem
- Limited Remedial Investigation Summary
- Overview of Report
- Demography
- Land Use
- Natural Resources
- Climatology
- Updated Base Map
- Hydrogeologic Features
- Surface Features
- Soil Features
- Surface Impoundment(s) Features
- Site Health and Safety Features
- Bench and Pilot Tests (if applicable)
- Potential Receptors
- Public Health Issues
- Environmental Issues
- References
- Appendices

Evaluations of the expanded data base could indicate that the magnitude and/or complexity of the hazardous waste and environmental problems at the site are too great to remain within the scope of the limited RI/FS approach. If this is the case, a full-scale, comprehensive RI/FS may need to be considered in lieu of a limited single operable unit approach.

Limitations

Not applicable.

5.0 Limited Feasibility Study

As previously discussed, the activities of the limited RI are used to determine the extent of contamination and the threat of these contaminants to the public health and enviroment. The limited FS process involves the evaluation and selection of an appropriate remedy to prevent and/or minimize the threat these contaminants pose.

The remedy for the surface impoundment operable unit may be final or temporary in nature, depending on the site characteristics and other circumstances such as the level of analysis conducted. This flexibility is due to the fact that other remedial actions may be required for other contaminated areas on the site; therefore, a safety outlet to address all site contamination is provided beyond any interim remedy that is implemented for a surface impoundment operable unit.

The FS process may be thought of as consisting of two phases. The first phase involves determining the appropriate level of cleanup. The second phase involves determining the appropriate alternative to achieve these selected cleanup levels.

Figure 5-1 is a general overview of the feasibility study evaluation process through remedial action. A detailed discussion of the remedy evaluation and selection procedures of the limited FS process can be found in the *Guidance Document for Cleanup of Surface Tank and Drum Sites* (EPA, 1985). A detailed explanation of general contracting procedures can also be found in this referenced document.

5.1 Final Remedy

The final remedy for the surface impoundment operable unit should be a permanent remedy that provides adequate protection to the public health and environment in the short and long term. Final remedies must have well defined objectives. For example, the ground water response actions must be known for the site. Typically this would involve the removal of any aqueous material in the impoundment and removal, stabilization, treatment, and/or isolation (individually or in combination) of soils or sludges down to sufficient levels to protect the public health and environment. Backfilling and/or actual cover may also be necessary. Corrective action or long-term monitoring may be necessary for contaminated ground water.

5.2 Interim Remedy

The selection of an interim remedy would be based on the fact that definable objectives have not been set for the surface impoundment (after the limited RI/FS activities) but source reduction is desired before addressing all other contaminated areas of the site. For example, ground water response actions may not be finalized. Future actions will therefore determine the ultimate level of cleanup for the operable unit. Obstacles to clearly defined objectives may be modeling and data uncertainty, and uncertainty of health based cleanup levels.

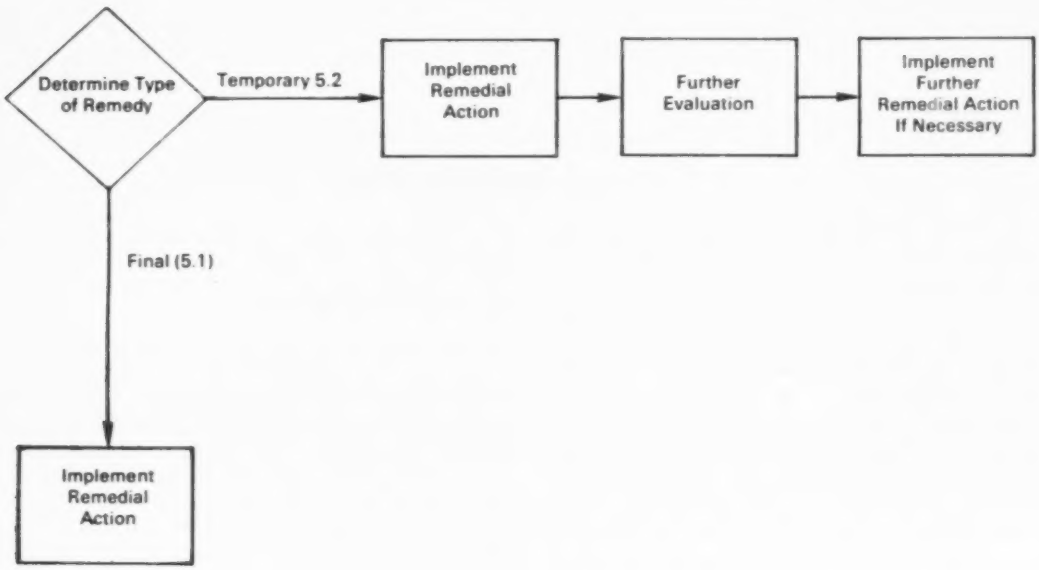
An interim remedy would be similar to a final remedy involving the removal of any aqueous material and removal, stabilization, treatment, and/or isolation (individually or in combination) of soils/sludges down to levels that would reduce contaminant migration. This level may not be to the extent that is ultimately necessary to protect the public health and the environment in the long term. This approach is generally not appropriate if capping or backfilling of the residual is necessary. The risks associated with the operable unit concept discussed previously are inherent with selecting an interim remedy over a final remedy. In these situations, removal levels for interim remedies may be based on engineering criteria that make sense from a technical viewpoint.

Engineering criteria are short-term remedial actions; therefore, the impoundment must also be left in an environmentally sound condition. Diking and drainage improvement measures may be necessary to prevent or minimize any remaining contaminant movement and exposure.

Verification monitoring may also be necessary to determine the adequacy of the interim cleanup levels.

The ultimate cleanup level and remedy for the impoundment may be delayed until a remedy for the entire site is selected. The site may be deleted from the NPL when the implemented action meets environmental and public health protection goals.

Figure 5-1. General overview of limited FS process.



6.0 Reference Guide

The references included in this section are organized according to the section titles of this guidance manual. Some entries are cross-referenced when they apply to more than one area. The list, which includes sources of information beyond those cited in the text of the document, is intended as a bibliography of resources but is not all inclusive.

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1.0 Introduction

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4.0 Limited Remedial Investigation

4.1 Develop Site Description and Data Base

4.1.1 Obtain Available Data

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4.1.2 Review and Evaluate Available Data

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4.4 Conduct Detailed Field Investigation

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